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ANNALS *of* SURGERY

Vol. XCVIII AUGUST, 1933 No. 2

ANNULAR GASTRECTOMY

FURTHER OBSERVATIONS ON THE CAUSE OF ITS FAILURE

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of New York, N. Y.

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The purpose of this report is not to recommend the annular or sleeve resection of the stomach but rather to set down certain technical factors that have entered into the cause of its failure. The literature ascribes stricture as the cause, but, inasmuch as cicatricial narrowing has not been the experience of all, there must be certain operative incidents present in the performance of the resection at one time that are not present at another time. It seems probable that if the clinical instances of outstanding failure be critically studied and checked up against properly controlled experimental technics some findings of clinical value should be forthcoming.

It is understood that constitutional factors must necessarily enter into the healing process of each individual's tissues and must constitute a variable which of themselves may account for healing to be rapid in one patient and retarded in another. These include congenital or inherited tendencies in wound repair, sympathetic nerve and glandular secretory influences upon the circulation and neuromuscular activity of the stomach, toxæmias, systemic infections, organic disease, and malignancy. The increased mortality of operations in diabetics, cardiacs, and carcinomatous patients compared with similar operations in strong adults with chronic ulcer is generally known. One must depend upon the elimination of patients in whom these factors make too bad risks for operation by the processes of careful history taking, physical and laboratory examinations, and by medical consultations.

Annular resection has not been performed in over a decade upon the third division at Bellevue Hospital. In the original six operations performed by the author no strikingly unfavorable technical results were observed. One of these came up for secondary operation for a new growth at the pylorus and although the gastro-gastrostomy wound was so smooth as to be imperceptible, the occurrence of malignant disease in the remaining pyloric portion very strongly argued in favor of a subtotal resection for the primary operation. It was observed in these and others of the same period that the early convalescence was remarkably natural so that it was possible in an asthenic patient with a post-operative pneumonia to commence rather energetic gastric feedings with toleration by the patient within the second week. The leaving in of the pyloric end, besides constituting in itself a possible site for ulcer or new growth, interferes with the normal inter-

change of duodenal secretions. This remnant is cut off from the coördinating influences of the gastric vagi through transection of the stomach and develops an intrinsic hypermotility which acts as a barrier to regurgitation of alkaline secretions. The post-operative acidities remain little changed. In this experience it has been this pyloric remnant with its interference with the alkalinization of the stomach and the dangers of recurrent ulcer or new growth that have militated most against the wisdom of using this operation.

The local technical factors which pertain as well to a gastroenterostomy suture line have been considered to be: vasoligation and its restriction of the regional blood supply, suture tension and its further reduction of the remaining circulation after necessary ligations of bleeders, and contamination.

The stomach is generally recognized as a vascular organ. Bernheim[1] in attempting to produce necrosis and ulcer by devascularizing the stomach concludes: "The stomach (of the dog) can withstand any amount of diminution of its blood supply, whether on the lesser or greater curvature, or on both, short of total devascularization. . . . Collateral circulation must be not only most extensive but most active and effective. Ligation of blood-vessels does not give rise to ulcers." Similarly, one of our own group had performed a series of regional vascular ligations about wounds in canine stomachs and noted the effects upon healing. J. Mulholland repeated experimentally what is done in a limited way clinically: that of picking up bleeding vessels a short distance back from the cut edge of the gastroenterostomy stoma and ligating them, except that he ligated a series of vessels entirely about the stoma. Mulholland's results appear in the following table:

TABLE I

Table Showing Influence of Vasoligation 2.5 Centimetres from Suture Line upon Resulting Size of Stoma

	Date of Operation	Time in Days	Stricture
Dog No. 1	11/16/28	157	0
Dog No. 2	11/21/28	145	1 +
Dog No. 3	11/23/28	27	1 +
Dog No. 4	12/6/28	16	3 +
Dog No. 5	12/8/28	40	0
Dog No. 6	1/31/29	39	0
Dog No. 7	3/7/29	59	2 +
Dog No. 8	4/4/29	21	2 +
Dog No. 9	4/11/29	7	3 +
Dog No. 10	4/13/29	40	0

From the above it appears that stricture to some degree follows in 60 per cent. and no stricture in 40 per cent.

From these observations it is evident that the marked vascularity of the normal stomach is ample to provide for the healing of a stoma under ordinary conditions but that it is possible to carry ligations so far as to cause the development of stricture.

A similar situation arises in respect to the gastro-gastrostomy wound in annular gastrectomy. In this technic several vessels are necessarily ligated.

In this manner it may be assumed that practically the same amount of blood will be removed from the healing wound by a number of operators. It is not conceivable, however, that many operators will exert the same degree of tension on the sutures. Still it is this element in the individual operator's technic that determines the net amount of blood flow to the granulating and epithelializing wound. This factor, tautness of the suture, may therefore account for the variable results obtained by various operators in the performance of the operation.

To observe the effects of taut suturing, stomachs were divided each into two transverse planes and resutured using a taut shoemaker's stitch in an anastomosis and a Connell and Cushing-Lembert gently drawn so as to leave

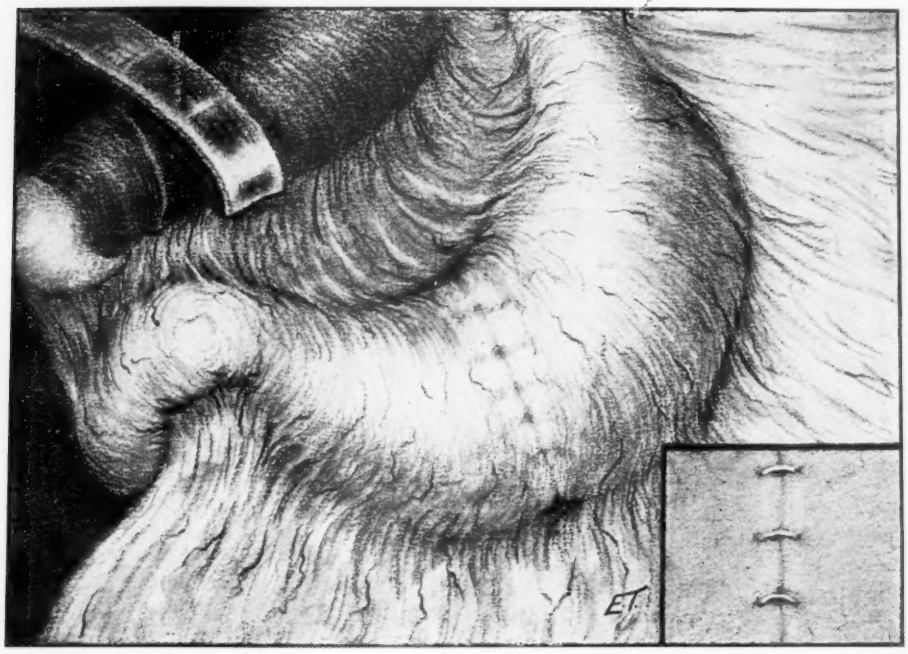

FIG. 1.—Drawing of gastro-gastrostomy with properly inserted sutures, indicating normal size relations of oral and aboral portions of stomach. (Insert indicates vascular changes about and between sutures drawn with proper degree of tension in the course of gastro-gastrostomy.)

a faint pink suture line in the remaining anastomosis in each stomach. (Figs. 1 and 2.) In these experiments, tautness was exaggerated to emphasize the pathological changes. Ischæmia was followed by distortion of the suture line and fibrosis or perforation. This problem was duplicated by Dr. H. Behrens while a graduate student at the University upon the author's suggestion. He performed eight gastro-gastrostomies, one on each experimental animal. The sutures were inserted to "approximate" tissues in two. In these the stomata were found free from stricture after three weeks. In three animals after a suture "drawn tightly" in twenty-eight, four, and ninety days respectively, the stomata were "slightly contracted," free from stricture, and "markedly" strictured. After five, twenty-one, and three days respectively, "very tightly drawn" suture lines were found "necrotic," "extremely

strictured," and "necrotic." Behrens" conclusions were: "Very tight sutures strangulate and lead to various degrees of necrosis including ulceration. Moderately tight sutures lead to stricture. Sutures inserted to approximate the serous surfaces favor healing of the suture line with a minimum of scar tissue or stricture formation."

Subsequently two more post-graduate students, Drs. S. Mufson and S. M. Rabson, using twenty dogs, endeavored to determine what amount of stricture followed annular resection. Resections of segments of 1.0 to 3.0 centimetres at the lesser curvatures and 1.5 to 7.0 centimetres on the greater curvatures were excised from the midgastric portions of five dogs, from the junctions of the middle and lower thirds in seven, and from prepyloric

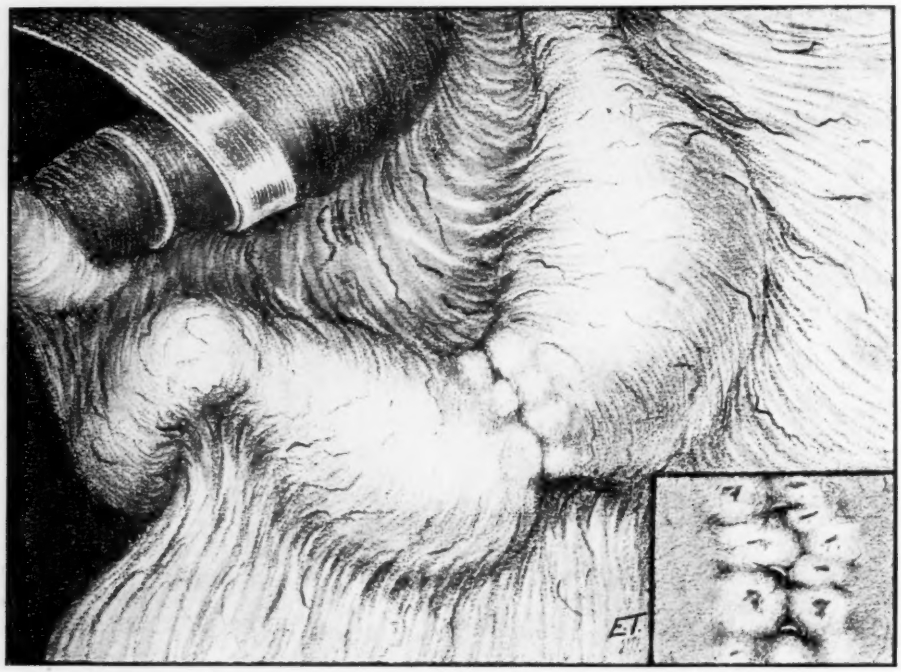

FIG. 2.—Drawing indicating strictured anastomosis between oral and aboral portions of stomach following tightly drawn sutures. (Insert indicates vascular changes about and between strangulatory sutures.)

portions in eight dogs. Of these twenty animals, there were fourteen properly sutured gastro-gastrostomies and six taut anastomoses. The mean duration of life of the former group was thirty days and of the latter ten days. There were two deaths from leakage at the suture lines in the group of fourteen "properly" sutured animals and four from leakage at one or other curvatures, more often at the greater, in the tautly sutured group. Histologically they report moderate cellular reaction except about the sutures where dense infiltration was noted as late as 153 days. Marked cellular infiltration and necrosis were observed in the perforated animals. Mufson and Rabson conclude: "All dogs in which sutures were tautly drawn died within

ten days from perforation or hæmorrhage. Taut sutures invariably led to necrosis so that in this series it was impossible to study fibroid changes in late suture lines. The properly sutured normal animals that survived several months showed röntgenographically no evidence of biloculation or of impaired motility and on necropsy no evidence of 'hour-glass' deformity other than projecting edges at suture lines."

These findings agree with those of Stewart[2] and Barber[3] in earlier papers. It is noteworthy that in those instances in which gangrene developed during the course of healing after gastro-gastrostomy it more often appeared at the greater curvature. This corresponds with the experimental findings of Bernheim and also with the pathological changes reported in occasional clinical failures.

Another factor to be considered in all operative technics is contamination. This factor was purposely combined with that of suture tension in a large series of experimental wounds by Doctors S. Davidson and J. R. Murphy during the past year. The results may be tabulated as follows:

TABLE II

Tissue Reactions to Taut and Contaminated Sutures in Wall of Canine Stomach

	Hæmorrhage			Leucocytes			Fibroblasts			Necrosis		
	T	L	C	T	L	C	T	L	N	T	L	C
Mucosa				x		x	x?	x?				
Submucosa	xx		x	xxx	x	xx	x?	x?		x	x	x
Muscularis	x	x		xxx	x	x	x?	x?				
Serosa	xx	x	x	x	x	x	x?	x?		x		

"T" refers to suture drawn more tightly than normally, "L" indicates normally tense suture, and "C" suture moistened in gastric secretion; "x" denotes degree of hæmorrhage, number of leucocytes, *etc.* All experiments were terminated by euthanasia.

Their conclusions were: "The only definite findings which can be drawn from the above is that fibroblasts appear sooner and fibrous tissue was longer observed in the clean than in the contaminated sutures." The taut suture stimulated an early outflow of leucocytes, more than either "contamination" or the "loose" suture. Some of these white cells may have come into the outer layers of the gastric wall in the hæmorrhage (noted more commonly after the tight suture in the above table). Abscess and necrosis were not outstanding after taut, "loose," or contaminated sutures in the hands of the above investigators.

From these several observations on normal stomachs by various investigators, it seems probable that the stricture often reported as the essential cause of failure after mesogastric resection is partly due to the requirements of the operation itself, which compel ligation of both curvature vessels and multiple ligations of mural branches, but also to overtaut sutures in the anastomotic line that further reduce the blood supply to the healing gastro-gastrostomy wound.

In abnormal stomachs in pathological individuals with impaired circulation or with poor neuromuscular tone as is often met with in carcinomatous patients necrosis may prevail in the absence of a firm replacement fibrosis and go on to perforation. (Figs. 3 and 4.)

The post-mortem drawings (Figs. 3 and 4) refer to a young adult male with carcinoma of the stomach and upon whom a Polya resection was performed. He reacted naturally until the seventh post-operative day when he developed a rise in temperature, distention,* and discharge from the wound (beginning peritonitis) and nephritis. His blood-pressure, low throughout, reacted to transfusion but never rose above 100 systolic

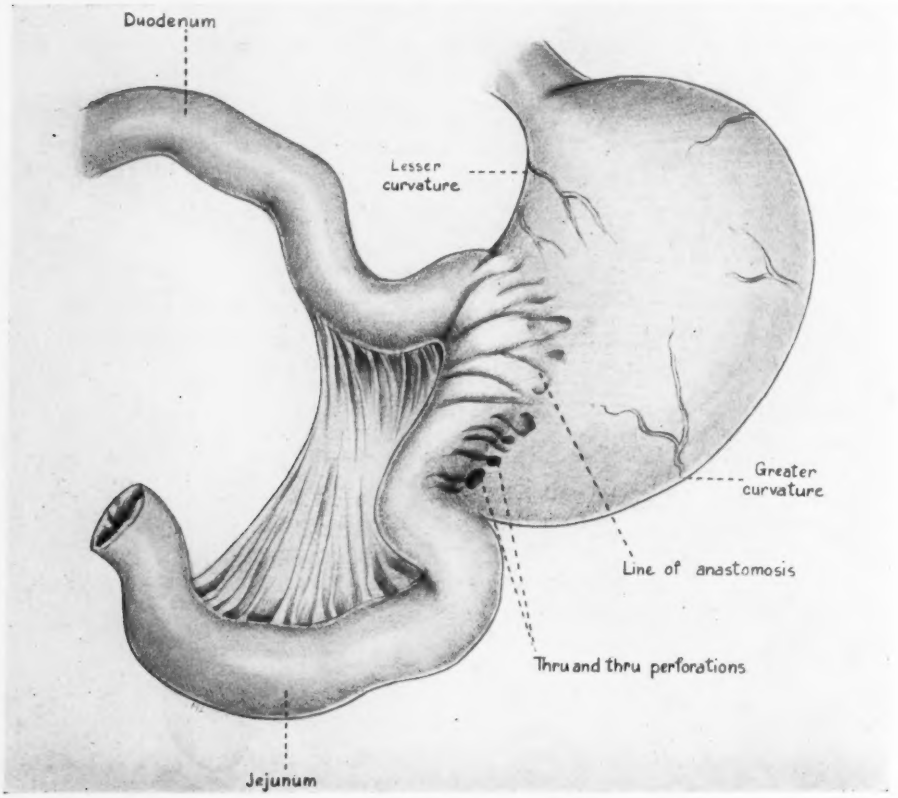

FIG. 3.

while leucopenia persisted. Of special significance are the necropsy findings ten days after operation which besides organic disease in the lungs, liver, and kidneys were: "Section through gastrojejunal junction shows œdema of the muscularis and foci of lymphocytic infiltration. In deeper layers of muscularis there are foci of necrotic material containing much nuclear debris. In one of these foci a bit of highly refractile material suggestive of catgut is seen. Serosa is covered by several layers of fibrin. Gastric mucosa shows superficial erosion and œdema of glands, many of which are desquamated. Same on the jejunal side. Another section through the gastrojejunal margin shows superficial erosion, focal necrosis in the mucosa, œdema in muscularis, and acute fibrinous exudate over the serosal surface. *Diagnosis.*—Necrosis at the gastrojejunal anastomosis.

* The author desires to call attention to the frequent absence of the usual signs of tenderness and rigidity in acute peritonitis in patients of extremely lowered resistance.

The anastomosis held for the first week. There was fibrinous exudate but no new connective tissue. Necrosis terminated fatally.

From this experience with the normal and pathological stomachs the following precautions stand out:

(1) Ligate bleeders in the cut edges of the wound rather than at a distance from the line of incision.

(2) Draw in sutures so as to approximate rather than so as to distort or blanch the tissue.

(3) In patients of doubtful operability take the greatest possible ad-

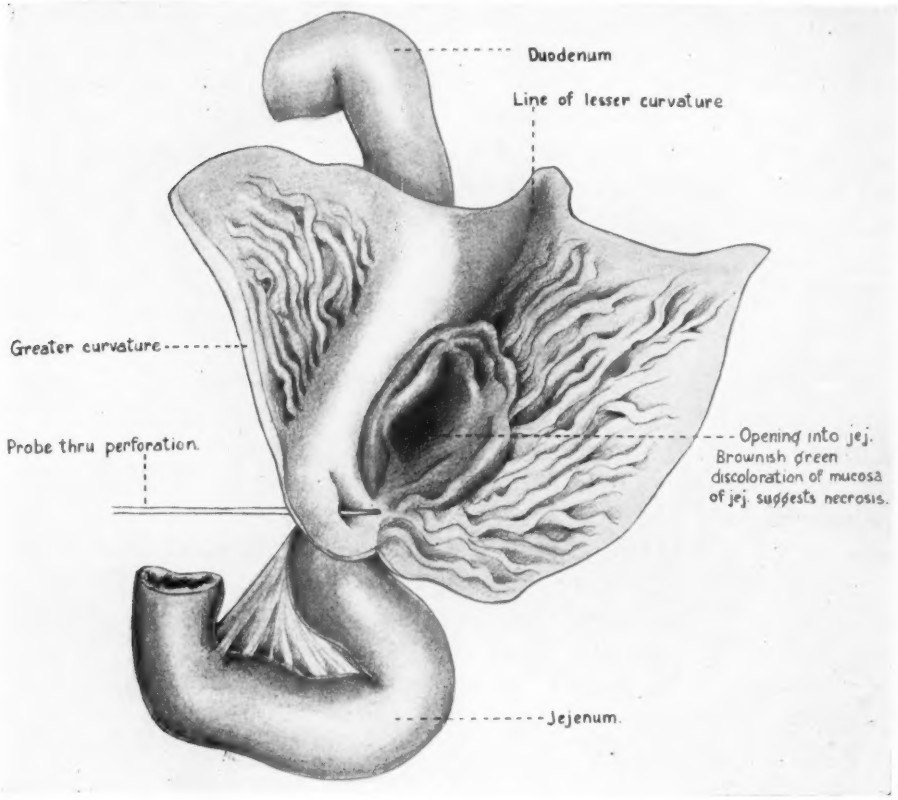

FIG. 4.

vantage of the adhesive inflammation destined to appear on the serosal surfaces of the wound by the application of omental or peritoneal grafts.

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TUMORS OF THE STOMACH*†

By Waltman Walters, M.D.

of Rochester, Minn.

from the division of surgery of the mayo clinic

The most common tumor of the stomach is carcinoma. A larger proportion of carcinomas occur here than in any other organ of the body, and gastric carcinoma affects three times as many men as women. Carcinoma of the stomach, as is true of carcinoma in most other regions, is curable in its early stages and hopeless when it has progressed so that the neoplasm cannot be removed; control of the disease rests primarily on its early recognition so that surgical removal can be accomplished. The disease appears in persons between the ages of forty and sixty-nine years in 85 per cent. of the cases. The symptoms, signs, and course of the disease are dependent, in large measure, on the situation, extent, and rigidity of the growth. In certain situations in the stomach, namely, in the upper and middle portions, carcinoma may appear and develop, producing few symptoms, whereas growths that interfere with emptying the stomach give rise to marked disturbance even in their early stages.

In general, the most important and most frequently occurring symptom is persistent, dyspeptic discomfort. In some cases symptoms suggestive of an ulcer may have been present over a period of years, later to assume malignant characteristics, such as failure of the patient to obtain relief from pain by methods which previously had been effectual. There is a relatively small group of patients who have had indigestion of an irregular nature, sometimes the result of a diseased appendix or gall-bladder, with mild symptoms, and the change to symptoms characteristic of carcinoma is so insidious that the patient is without knowledge of the change.

Carcinoma of the stomach can be detected by a competent röntgenologist in 95 per cent. of cases. It should be emphasized that röntgenological examination of the stomachs of patients forty years of age or more, who have indeterminate dyspepsia, is the most important procedure in examination, and should never be omitted in any suspicious case.

Two cases which recently came under my observation have emphasized the value of the röntgenological examination in cases of early carcinomatous lesions. In the first case, the presence of a small, carcinomatous, ulcerating lesion, 1.9 by 1.7 centimetres, was detected by the röntgenologist, found and removed by the surgeon, and the pathologist confirmed the diagnosis of malignancy. In the second case, that of a man aged thirty-two years, the röntgenologist had made a pre-operative diagnosis of small, ulcerating malig-

* Read before the New York Academy of Medicine, Graduate Fortnight, October 26, 1932.

† Submitted for publication November 14, 1932.

nant lesion of the lesser curvature of the stomach. At operation, with the lesion between my exploring fingers, I felt that it was inflammatory. The distal half of the stomach and the first portion of the duodenum were removed, nevertheless, because of the uncertainty of the nature of the lesion, and the pathologist reported it to be an adeno-carcinoma, graded 2.

The difficulty and importance of diagnosis of a malignant lesion of the stomach has been well stated by Balfour: "There is no characteristic syndrome of carcinoma of the stomach. Although there is a more or less constant syndrome in the average case, there are so many exceptions to the rule that the astute clinician will, by keen recognition of this fact, establish a diagnosis of the disease at a time when the symptoms are bizarre and when surgery can offer some prospect of cure."

Types of malignant gastric lesions.—Ulcerating adeno-carcinoma of the stomach is of most frequent occurrence. The lesion tends to be more painful than other types and blood oozes from it more freely. Large tumors of the stomach are usually of the colloid type; the lesions are sharply demarcated, and thus readily lend themselves to removal by extensive resection of the stomach. This should emphasize the point that it is not the size of the lesion, but its mobility and extent, which determines whether it can be removed. The scirrhous type of lesion is frequently localized at the antrum of the stomach, producing symptoms by obstruction, whereas the linitis plastica type, with involvement of the entire stomach, may exist with but few symptoms until late in its progress. Sarcoma of the stomach occurred in the proportion of one sarcoma to 159 carcinomas in the years 1908 to 1920 at The Mayo Clinic, as reported by Masson. It might be said in general that sarcoma of the stomach occurs earlier in life than carcinoma. In a study of fifty-four cases of sarcoma of the stomach seen at the Clinic from 1908 to 1929, Balfour and McCann found that in all but one case the patient had come to operation. The majority of the lesions were diagnosed as carcinomas of the stomach before operation, and the lesions were removed surgically in thirty-six of the cases.

Surgical Treatment.—It has been the custom at the Clinic to advise abdominal exploration in all cases of carcinoma of the stomach, unless unremovable metastatic growths have been proved to exist. The rationale of such a decision rests on the basis that occasionally röntgenograms will give evidence that a lesion is of greater extent than it really is, and frequently the stomach is found to be unusually movable, a circumstance that makes any localized gastric carcinoma suitable for removal.

Occasionally the presence of a benign tumor of the stomach, such as a benign polyp or foreign body, may produce a large defect in the filling of the stomach, leading to an erroneous opinion as to the type and extent of the lesion. In an occasional case a badly diseased and distended gall-bladder or distension of the splenic flexure of the colon from gas, or the presence of other lesions in adjacent viscera, may so interfere with the neuromuscular activity of the stomach that apparent defects in outline suggestive of carci-

noma manifest themselves. When such disturbances involve the upper portion of the stomach, they may lead to the erroneous interpretation that the lesion is inoperable.

In the last few years, I believe we have been able to remove an increasing number of extensive malignant lesions of the stomach. This has been partially due to the fact that a patient is never denied the benefits of removal of a malignant gastric lesion if it is possible to remove it. In the last three years total gastrectomy has been performed at The Mayo Clinic in seven cases. It is interesting that three of the seven patients are living and well, more than a year since operation; one, almost two and a half years since operation; another two years since operation, and another more than a year since operation. That such an operative procedure could be carried out in suitable cases, with great benefit to the patient, has led to the impression that gastric lesions, therefore, should be removable unless they have invaded adjacent structures and thus could not be removed in their entirety.

In many instances in which the lesion at first would appear to be incapable of removal, because of extent of the growth and attachment to the mesocolon or capsule of the pancreas or liver, it is found after the freeing of adhesions, and separation of the lesion from these structures, that the growth is readily removable. In other cases, particularly if the tumor is large, the uninvolved portion of the stomach may be thickened and give the appearance of involvement, although thickening may be only the result of gastritis adjacent to the lesion. Finally, it is not an uncommon experience to find that a growth examined while the patient is straining under light anæsthesia appears unremovable, but under deep anæsthesia it may appear to be readily removable.

In general, the statement can be made that approximately half of the patients who are in suitable condition for exploration for malignant lesions of the stomach, will be found to have operable lesions.

The Curability of Carcinoma of the Stomach.—In the symposium on carcinoma presented at the Clinical Congress of the American College of Surgeons in New York last year, Balfour reported a group of 278 patients who had lived for five years or more following removal of carcinomas of the stomach, stating that five-year cures could be obtained in 50 per cent. of the cases in which the lymph-nodes were not involved. This statement should not be construed, however, to mean that the presence of involved lymph-nodes is a contra-indication for operation; in many of the 278 cases there was involvement of lymph-nodes.

It should be remembered that enlargement of lymph-nodes along the curvatures of the stomach does not necessarily mean involvement by carcinoma, for microscopical examination of many of these enlarged nodes will show them to be inflammatory and to contain no cells of carcinoma. In either event, complete removal of all enlarged nodes in the gastrohepatic omentum, along the lesser curvature of the stomach, as well as those along the greater curvature of the stomach at the time resection is done, is the advisable procedure.

Palliative Treatment of Inoperable Malignant Gastric Lesions.—In discussing the treatment of carcinoma of the breast, and its recurrence, Handley stressed the point that we must not be content to treat only the operable or curable cases of malignant disease but that any procedure which can be carried out for the patient with a recurring malignant lesion or an inoperable malignant lesion, which will make the remainder of the patient's life more comfortable, is our duty. No better example can be found of the value of palliative measures than in surgical treatment of inoperable carcinomas of the stomach.

Removal of a necrotic, ulcerating, bleeding lesion of the stomach, even though metastasis may be present in the liver, is a palliative procedure worthy of consideration in dealing with a patient whose general condition warrants it. Similarly, in the presence of obstruction, gastroenterostomy will not only bring relief of the distressing vomiting, but will enable the patient to take adequate nourishment, and these effects of the operation mean restoration of weight and improvement in general well-being. Mayo and Balfour have both directed attention to the fact that patients may live, two, three, and four years, in good health, following palliative removal of a malignant lesion of the stomach, even if metastasis was found at the time of the operation. This is particularly true regarding hepatic metastasis, which seldom becomes a site of infection.

In cases in which palliative resection or gastroenterostomy seems inadvisable, jejunostomy can be performed for feeding, and the patient's stomach can be kept empty subsequently by means of a stomach tube. Emphasis again should be placed on the fact that relief of symptoms and prolongation of life often can be afforded the patient with incurable carcinoma by treatment directed to these ends.

Benign Tumors of the Stomach.—Benign tumors of the stomach, although of rare occurrence, may give rise to pyloric obstruction, due to their intermittent prolapse through the pyloric sphincter, or they may be the cause of severe gastric hæmorrhage, due to ulceration. In 1922, Eusterman and Senty reported a series of twenty-six surgical cases of benign gastric tumor, and in 1927 Balfour and Henderson added thirty-two in which operation had been performed at the Clinic up to 1927. These benign tumors consisted, for the most part, of fibro-adenomatous polyps and other tumors of the gastric walls, namely, fibromas, myxomas, fibro-adenomas, adenomyomas and myxo-fibromas. These tumors varied from one of slight weight, 5 millimetres in diameter, to one weighing 1,000 grams. This large tumor was a dermoid cyst filling the retroperitoneal cavity. In twenty-two cases the tumor was associated with other lesions; in five, with carcinoma of the stomach.

It is interesting that in all cases of gastric polyp uncomplicated by other gastric lesions, free hydrochloric acid was absent from the gastric content. This tends to obscure the differential diagnosis of gastric carcinoma, pernicious anæmia, and benign gastric tumor. The tumors are relatively symptom-

less unless the pedicles are of sufficient length to allow the tumors to prolapse through the pylorus, producing intermittent obstruction, or unless they become ulcerated and produce bleeding.

The malignant potentiality of all polypoid tumors of the stomach closely parallels that of the same type of tumor occurring in the colon; therefore, the pedicle of each of these lesions should be carefully examined at the time of removal to be certain whether malignant cells are present. In one of the cases reported by Balfour, a polyp approximately 7 centimetres in diameter, situated near the cardiac end of the stomach, was suggestive of malignant degeneration. Although the tumor was rather inaccessible it was cauterized and removed at the pedicle. Four months later, exploration revealed an inoperable carcinoma of the cardiac end of the stomach, apparently originating at the site of the polyp.

From the standpoint of treatment of the lesion, transgastric excision of the tumor when benign, as was done in seventeen of the thirty-two cases, is worthy of consideration. However, in larger tumors the probabilities of malignant degeneration makes partial gastrectomy advisable.

Present Status of Peptic Ulcer.—The present status of the surgical treatment of duodenal and gastric ulcer might be said to depend on the results which are obtained in suitable cases under a medical regimen. I have said "suitable cases," because I want to attempt, first, to eliminate from consideration those cases in which there is unanimity of opinion regarding treatment. For example, acute duodenal or gastric ulcer, which has perforated, is recognized by everyone to constitute a surgical emergency, and closure of the perforation is necessary. Whether, in addition to this, other procedures, such as gastroenterostomy or gastric resection should be done is dependent on the condition of the patient, and on what, in the experience of the operating surgeon, has given the best results at low rates of mortality in other cases of similar type.

The patient with a chronic duodenal ulcer without complications, whose symptoms are mild, neither interfering with work nor his pleasure, is best treated medically. Patients with subacute, perforating duodenal ulcers, especially those in whose stomachs evidence of a crater can be demonstrated röntgenologically, patients with bleeding duodenal ulcers, and patients with obstructing duodenal ulcers, are best treated surgically. In addition to these patients who have these complications, there are a great many with chronic duodenal ulcers whose symptoms do not respond to a medical regimen, and who welcome a surgical procedure of low risk that will afford them relief.

It might be said that in the treatment of any lesion, ulcerating or otherwise, duodenal, gastric, intestinal or vesical, direct attack on the lesion, and its removal, when such can be accomplished safely, is the advisable procedure. Unfortunately, removal of the complicated type of duodenal ulcer cannot always be accomplished safely. The obstructing duodenal ulcer is frequently adherent to the pancreas, and is surrounded with much inflammation and œdema, and its removal is carried out with a great deal of difficulty, especially

when too small a part of the duodenum remains to permit of perfectly accurate closure after gastric and duodenal resection. The same applies to hæmorrhagic duodenal ulcer, which usually is situated low on the posterior wall of the duodenum. Such a bleeding lesion usually has perforated into the head of the pancreas, forming a craterous ulcer. That an ulcer of this type may be present, even though an ulcer is present on the anterior wall of the duodenum should be remembered. It should be suspected in every case in which there has been intestinal bleeding, even though Röntgen-rays fail to give evidence of its presence.

Typical biliary colic, occasionally with some jaundice, may result from perforating ulcers of the posterior duodenal wall. Many such patients whom I have seen had had their gall-bladders removed elsewhere, and I suspected the presence of stone in the common bile-duct, with recurrence of symptoms. Perforation of the ulcers into the pancreas was the cause of recurring attacks of pain, and the jaundice was the result of inflammatory œdema of the pancreas, obstructing the pancreatic portion of the common bile-duct. The situation of the ulcer on the posterior wall of the duodenum, and its perforation into the pancreas at a low level, without involvement or deformity of the anterior wall, had prevented its röntgenological visualization in some cases. In some of the cases the lesion had been overlooked at the time of the previous exploration, presumably because the anterior duodenal wall was not involved and the posterior wall was not palpated.

Occasionally severe, almost fatal, intestinal hæmorrhages occur from ulcers of the type just mentioned; hæmorrhages usually ceased after gastroenterostomy. I mention this particularly because many of the lesions one is most anxious to remove are of the type that can be removed only with the greatest difficulty, and with the greatest risk. We have traced such patients after gastroenterostomy, to see, with the greatest satisfaction, the symptoms of most of them disappear, and they regain their health. Furthermore, gastroenterostomy in these cases carried but little more risk than in the average case, which in our experience has been that of a mortality rate of about 1 per cent. One may contrast this mortality rate with that following removal of extensive perforating, obstructing, or hæmorrhagic duodenal ulcers, which in the hands of the most experienced surgeons is considerably greater.

The question of gastric and duodenal resection is introduced because, if one is to resect ulcerating lesions of this type in the duodenum, resection of part of the stomach usually becomes a part of the procedure. This brief consideration of the perforating, obstructing, hæmorrhagic type of duodenal ulcer emphasizes the necessity of basing one's opinion as to the best surgical procedure on knowledge of the pathology of the lesion itself, and of the alteration in physiology that results from the operative procedure.

May I say, therefore, that I am basing my opinion on the ulcerating lesions of the stomach and duodenum which we in the middle western part of the country are seeing at operation. In our experience, duodenal or gastric

ulcers are localized to either the duodenum or the stomach in 90 per cent. of the cases. This is in contrast to the ulcers which my colleague, Doctor Snell, and I saw operated on in the German surgical clinics. There, in addition to the duodenal ulceration, there was marked ulcerative and hæmorrhagic inflammation of the lower part of the stomach. Consequently, when this gastritis is found to be present in association with duodenal ulcer, it would seem that the type of the lesion must be entirely different from the type we see, not only pathologically, but biologically, and removal of the ulcerating portion of the stomach and duodenum should be the operation of choice.

With the lesion localized to the duodenum, and accessible, there is no reason why excision of the lesion and provision for the stomach to empty itself completely by a properly functioning gastroenteric stoma, or by means of the opening which results from pyloroplasty, should not be followed by excellent results. When the lesion is of the obstructing, perforating, hæmorrhagic type, in which removal of the lesion would seem to be complicated because of the greater risk involved, the safest, and therefore the wisest procedure to us, seems to be usually gastroenterostomy. If it becomes necessary at a later time to remove the lesion, which very seldom is the case, it will be found that because of the relief of the obstruction afforded by the gastroenterostomy, the inflammatory œdema and fixation of the lesion has subsided to the extent that the lesion can be more easily and more safely removed.

One of the most startling effects of gastroenterostomy which I have recently witnessed, was in a patient which I operated on for relief of a subacute, perforating duodenal ulcer forming a mass 5 by 3.5 centimetres in diameter and perforating against the under-surface of the liver. As a result, the patient was in poor condition, and although the operation was performed entirely under abdominal wall block anæsthesia with procaine, bilateral pulmonary abscesses developed. These were successfully drained through the bronchoscope. Unfortunately, septic thrombosis and septicæmia then developed, from which the patient failed to recover. The post-mortem examination of the stomach and duodenum, made six weeks following the gastroenterostomy, revealed the mass about the perforated ulcer to have disappeared completely; the duodenum had disengaged itself from the liver, and gross and microscopical examination of the ulcer disclosed that it had become completely healed, except for one small area 2 millimetres in diameter, situated in the superior margin of the posterior wall, where the perforation undoubtedly had taken place. With the exception of this small area, the mucous membrane had completely closed over the ulceration.

I am convinced that patients who have lesions of the duodenum associated with lesions of the stomach are best operated on by removal of the areas of the ulceration. On the other hand, the infrequency with which such accompanying inflammations of the stomach have been present in patients operated on by me in the last eight years has led me to believe that in by far the

majority of cases, excellent results can be expected by the conservative operations of gastroenterostomy or pyloroplasty, with later excision of the ulcer if necessary. These procedures can be carried out with minimal risk.

Gastric Ulcer.—In considering the treatment of gastric ulcer, I should like briefly to call attention to several observations which I think worthy of emphasis.

Statistics, based on cases in which operation for gastric ulcer has been performed in various clinics in this country and abroad, would lead one to believe that from 10 to 20 per cent. of gastric ulcers which seem benign are in reality small carcinomas. Whether these are ulcerating carcinomas or whether they are carcinomas developing in an ulcer is of great interest to pathologists and students of etiology, yet from the practical standpoint, the fact that an ulcerating lesion of the stomach, no matter how small, may be carcinomatous, is of extreme importance.

I have removed an ulcerating carcinoma of the stomach, about 1.5 centimetres in diameter, which when subjected to röntgenological examination, and even when palpated at the time of the operation gave none of the indications of being malignant. Microscopical examination, however, demonstrated that the lesion was carcinoma. On a few occasions attempt to treat these lesions medically was followed by apparent success, the clinical features of a benign lesion being temporarily satisfied. There was relief of pain, absence of blood in the stools, and disappearance of the niche on röntgenological examination. Later, however, return of symptoms, and reappearance of the lesion in the röntgenogram led to exploration, at which time an extensive malignant lesion was found. One patient, I recall, insisted on being treated medically, but the symptoms reappeared to a more severe degree, and ten months later the patient willingly underwent exploration. Unfortunately, the lesion was found so extensively to involve the stomach that it could not be removed.

There is no doubt that medical treatment of gastric ulcers by an internist skilled in the treatment of gastro-intestinal disease, which treatment can be controlled and carried on under his observation, and the subsequent course of the patient carefully observed, is worthy of trial for certain types of gastric ulcer, particularly the acute type of gastric ulcer afflicting a young patient. It should always be remembered, however, that the decision to treat such a person by medical measures carries great responsibility, for if the lesion is malignant by the time it is found to respond unsatisfactorily to medical treatment, sufficient time may have elapsed for it to have become unremovable. It is our custom, at the Clinic, therefore, in cases of gastric ulcer which seem suitable for medical treatment, to keep the patients in the hospital under observation for three weeks. If during this time the ulcer does not respond to treatment, surgical removal is advised. Even in cases in which excellent progress is being made under medical care, the patient is advised to return at frequent intervals for reëxamination.

Summary.—Carcinoma occurs more commonly in the stomach than in any other organ of the body. The symptom of most common occurrence

is persistent dyspeptic discomfort. Carcinoma of the stomach can be detected by a competent röntgenologist in 95 per cent. of cases. Ulcerating adenocarcinoma is of most common occurrence, although large carcinomas of the stomach are usually of the colloid type. Sarcoma occurs in the stomach in proportion of one sarcoma to 159 carcinomas. Exploration for every tumor of the stomach is indicated, providing the patient's general condition permits, and unless unremovable, proved metastasis already exists. In several cases successful total gastrectomy for carcinoma has been performed at the Clinic. Balfour reported 278 cases in which the patients lived for five years or longer after surgical removal of gastric carcinomas. Palliative treatment of inoperable tumors should be directed toward relief of pain and obstruction and improvement in general condition. Removal of necrotic, ulcerating lesions is justifiable in selected cases, even in the presence of hepatic metastasis.

Benign tumors of the stomach, although of infrequent occurrence, may give rise to obstruction due to prolapse through the pylorus, or they may cause hæmorrhage, due to ulceration. A gastric polyp may be malignant, and its pedicle should be examined microscopically.

The present status of peptic ulcer might be said to depend on results obtained in suitable cases under a medical regimen. The decision for surgical treatment of duodenal ulcer should rest primarily on the nature of the lesion, and the presence or absence of accompanying gastric lesions, remembering that the safety of any operative procedure is dependent on the extent of the lesion, the condition of the patient, and the experience of the surgeon. Attention is directed to the risk of delay in the surgical treatment of gastric ulcers which do not respond to a medical regimen, and to the necessity of continual observation while carrying on medical treatment in all cases of gastric ulceration.

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TUMORS OF THE DUODENUM

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Useful knowledge can be obtained through the study of a large series of adequately detailed case reports. Tumors of the duodenum occur with such infrequency that the record of all cases is quite desirable. It is because of this fact and of the special and difficult diagnostic problems and the amenability of a large percentage of these growths to treatment that we present this brief review of the literature and report of a case.

A colored woman (Case No. 31—9143, Hospital No. S—1145), aged forty-eight years, was admitted to St. Philip Hospital July 10, 1931. Her chief complaint was a mass on the right upper thigh near the hip, and "stomach trouble." The tumor on the right thigh was first noticed in 1912. This began as "small knots" under the skin. Three masses were removed in 1918, but this operation was followed by a recurrence which had reached considerable size when removed again in 1926. A similar recurrence was removed again in 1929 and also in January, 1931. There was again a prompt return, and the mass in July, 1931, was as large as a small coconut.

The onset of abdominal distress dated to three months prior to admission. The pain was gradual in onset and of a dull, aching character. There was a constant sensation of gastric fullness and vomiting occurred frequently, especially after eating heavy foods. No blood has ever been noted in the vomitus. Soft and liquid foods could be tolerated. The pain had occurred intermittently since its onset but had grown more severe and more frequent one month prior to admission. At this time the attacks were occurring in frequent colicky paroxysms lasting twenty to thirty minutes. During the attacks a swelling would form in the upper abdomen which would disappear after pain subsided. She was not relieved by food, but was occasionally relieved by change in position and vomiting. She had lost forty pounds of weight.

The chief physical findings were emaciation; anæmia; slightly enlarged liver; an illusive palpable mass in the right upper quadrant felt only at times when the patient lay on her left side; a multilobular mass about the size of an adult fist on the external aspect of the right thigh infiltrating the skin and surrounding tissues, but not tender.

Laboratory Examination.—Hæmoglobin, 30 per cent. (Sahli); Wassermann, negative. The remainder of the examination was negative.

The woman was operated upon first for the removal of a tumor in the upper part of the thigh. Pathological examination showed it to be sarcoma. The pathological report by Dr. Pauline Williams is as follows:

Gross Description.—Specimen consists of nodular mass weighing 300 grams. It has been cut into. It measures ten by eight by six centimetres. One portion is covered by skin. The nodules vary in size from one centimetre to five centimetres in diameter. Most are circumscribed and some are encapsulated, elsewhere two and three merge together, and are enclosed in a thin membranous capsule. They vary in consistency from very firm to fairly soft tumors, the softer ones being pale and pinkish in color, the firm ones almost white, cut surface smooth and glistening.

Microscopical Description (Fig. 4A).—Broad bundles, longitudinal, cross-section

and oblique, composed of fusiform cells, constitute the essential structure of these tumors. The cells are rather uniform in shape and size, having vesicular nuclei and showing rather frequent mitoses. A fine intercellular reticulum composes the stroma; blood-vessels are not very abundant. A connective-tissue capsule envelops these growths, overlying one of which is thin skin.

Pathological Diagnosis.—Fibrosarcoma, relatively non-malignant.

A few days after removal of the mass on the right thigh, she was submitted to the X-ray department for gastro-intestinal study.

X-ray examination (Fig. 1) showed a dilated and atonic stomach with a considerable six-hour gastric residue. The duodenal bulb was markedly dilated. In the erect position the duodenal bulb was never filled out and there was a large, central, translucent filling

FIG. 1.—Röntgenogram in right oblique position, showing multilocular defect in bulb, with trabeculations. The general contour of the bulb is preserved.

defect with the periphery faintly outlined by a thin shell of barium. The cap did not fill out completely in the prone position and showed a large, constant deformity that varied from an irregular circular, or oval, to a multilocular one. The deformity was translucent, always outlined by the thin barium shell, and traversed by trabeculations. The defect was shown in the erect, right oblique, prone and supine positions. There was no evidence of duodenal constriction. The impression from the examination was that the deformity was produced by extrinsic pathology, probably a tumor in the region of the pancreas. The possibility of a duodenal tumor was considered, but on account of the great rarity of this, was considered as improbable. (E. L. S.)

About ten days following removal of the tumor from the thigh, the abdominal operation was performed.

The stomach was found greatly dilated, the first four inches of the duodenum was at

least three times its normal size, approximately two and one-half or three inches in diameter. There was felt within the lumen of the duodenum a hard tumor about the size of a hen's egg. (Fig. 2.) There were no adhesions or evidences of liver, gall-bladder or other abdominal disease, and it was decided to remove the pyloric portion of the stomach and the first three inches of the duodenum. This was easily accomplished, and an end-to-end anastomosis of the stomach and duodenum was made. The patient's condition was good for three days, taking liquid food; died rather suddenly on the third day with greatly dilated stomach.

A limited examination through the operative incision was made. The stomach was greatly distended, filling almost the entire abdominal cavity, the quantity of fluid within it could not be measured. The stomach had to be opened and the fluid evacuated before the examination of the site of operation could be made. We could not see any evidence of disease in other abdominal organs.

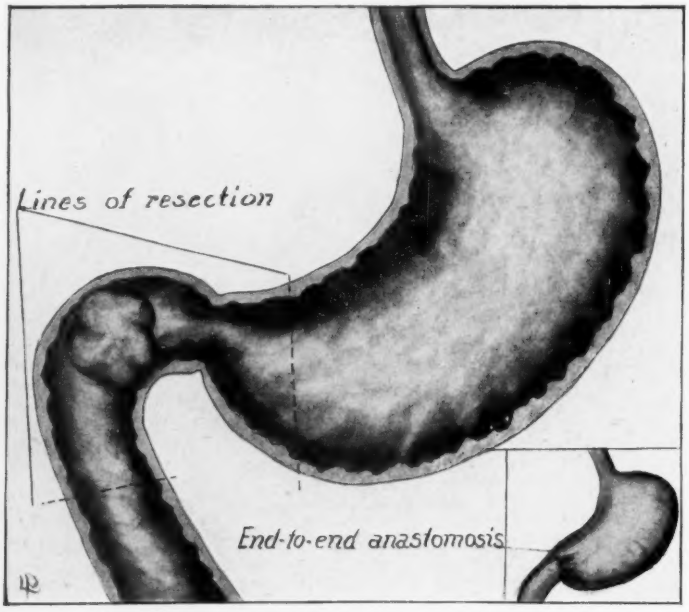

FIG. 2.—Diagram showing location of sarcoma of the duodenum, and line of resection. Insert shows end-to-end anastomosis of stomach and duodenum.

The site of anastomosis was removed intact, and submitted to Dr. Lewis C. Pusch, who found that the healing was proceeding normally, the lumen at the site of anastomosis admitted two fingers easily, there was no area of leakage, nor evidence of pancreatic disease. The cause of death was acute dilatation of the stomach. (LaR.)

Report of the examination of the tumor by Doctor Pusch was as follows:

Gross Description.—The specimen, 10 by 8 by 5½ centimetres consists of four centimetres of the pylorus of the stomach continuous with six centimetres of the duodenum. (Fig. 3.) It is received opened longitudinally revealing a firm, nodular, pinkish-white mass, 5½ by 5 by 3½ centimetres, having a circumference of eight centimetres, attached by a potential pedicle two centimetres in diameter to the mucosal surface of the duodenum, encroaching upon the pyloric orifice. The base and adjacent duodenal wall are not indurated. The serosal surface of the specimen opposite the base of the tumor presents a dimple-like depression two centimetres long. The surface of the mass resembles that of adjacent gastric and duodenal mucosæ; it is pinkish-white, not ulcerated, granular, or friable. Lymph-nodes are nowhere recognizable.

Microscopical Description (Fig. 5B).—The 5½-centimetre mass is composed essentially of fusiform connective-tissue cells, moderately anaplastic. Some areas are predominately fibrillar, suggesting the classification of fibrosarcoma, while others are densely cellular with ovoid vesicular nuclei. A few mitotic figures are seen. An invasive tendency is manifest. The tumor is not encapsulated.

Pathological Diagnosis.—Spindle-cell sarcoma.

DISCUSSION AND REVIEW OF LITERATURE

This study is limited to benign tumors and sarcoma of the duodenum. Carcinoma, ulcer, and diverticulum of the duodenum and tumors of all kinds in the small and large intestines and stomach are excluded. The text

FIG. 3.—Photograph of sarcoma of the duodenum.

of this paper is a case of large-sized sarcoma of the duodenum, metastatic from a sarcoma of identical type, located on the thigh. Details of three other cases of sarcoma and thirty-two cases of benign tumor of the duodenum have been collected from literature.

Formerly, tumors of the duodenum were encountered at the autopsy table and in dissecting rooms as interesting rarities. Within the last ten or fifteen years, as the result of better means of diagnosis, and the large amount of surgery being done upon the upper abdominal organs, we are acquiring familiarity with the disease.

Within the past ten years, the diagnoses have been verified by pathological examination, in fifteen cases of benign tumors and three cases of sarcoma.

Within the same period of time, X-ray has been brought to bear upon the diagnosis before operation, and sufficient data have been accumulated to enable diagnosis to be made now with reasonable certainty. X-ray findings are adequately described by Waters and by Finney.

The report of King collected the cases of benign tumor up to 1917. The article of Golden included those up to 1928. Balfour and Henderson reported additional cases in 1929; Bookman in 1930, Scofield in 1930, and Finney in 1931 each reported cases.

The three cases of sarcoma (Mostowska, Soli and Von Solis) and the case herein reported, are the only ones of sarcoma in which we can find that

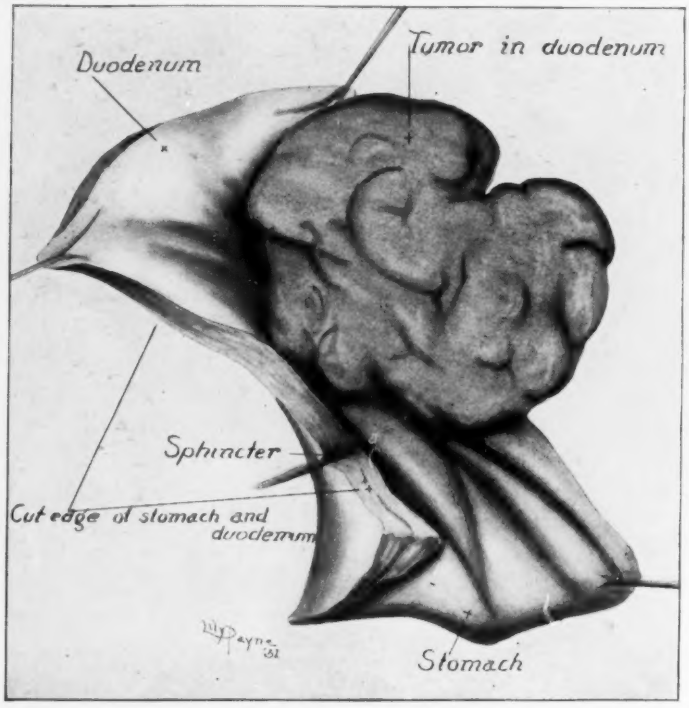

FIG. 4.—Artist's drawing of a side view of a sarcoma of the duodenum.

diagnosis was verified. The two cases by the others above referred to were primary of the duodenum, and had metastasized to the liver, the mesentery and the peritoneum. The case in this article was metastatic from sarcoma of the thigh.

In twenty-four cases of benign tumor, the lesion in the duodenum was the only one found in the small bowel; in eight cases there were multiple tumors located in the duodenum, small bowel and large bowel; and in most of these there was multiple polyposis. Two of the cases were in infants, eleven and nineteen days old, respectively. There was one case of a man seventy-five years old. The other cases range in age from seventeen to sixty-eight, the majority being found between thirty and sixty.

As to the nature of the benign tumors, twelve of the cases were adenoma, four were designated polyps, three myomas, one fibromyoma, one papilloma, one lipoma, one hæmangioma, one cyst, and several tumors of mixed type. Ulceration of the tumor or adjacent mucosa was present in one-fourth of the cases. The tumors varied in size from one to ten centimetres in diameter, and one of every four had pedicles. Questionable intussusception has been recorded only once.

Symptoms and Clinical Course.—As would be expected, the chief symptoms were those referable to indigestion. Epigastric pain of a colicky charac-

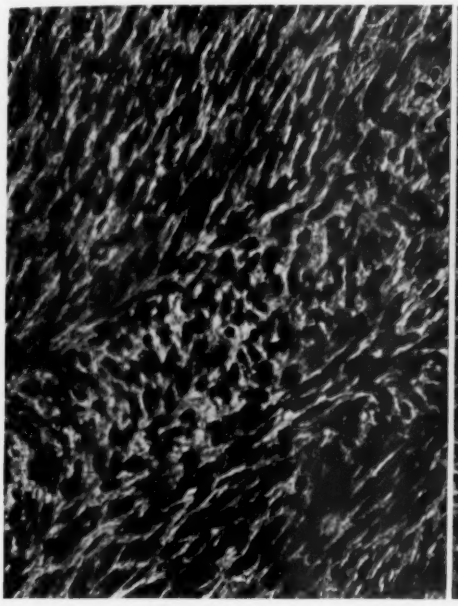

FIG. 5A.—Shows microscopical section of sarcoma of the thigh.

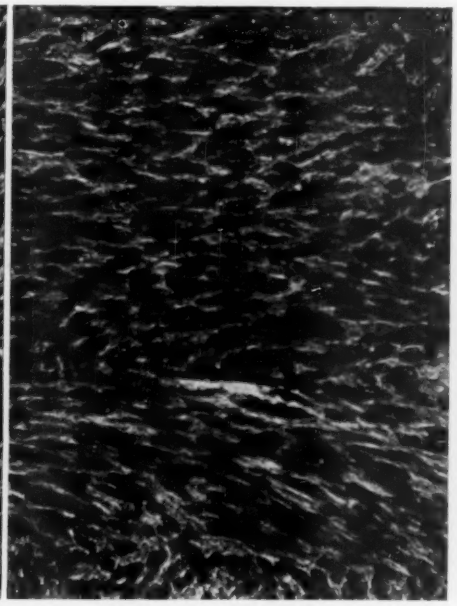

FIG. 5B.—Shows microscopical section of sarcoma of the duodenum.

ter was noted in all cases in which symptoms were recorded. The pain is recurrent, paroxysmal, variable in intensity, accompanied by tenderness, and attended or followed by vomiting. There is loss of appetite in all cases. Bowels are constipated or loose, and sometimes there is paroxysmal diarrhœa. Progressive weakness and loss of weight occur. Many cases have vomited and passed blood in the stools; in every case in which it is looked for, blood can be demonstrated by laboratory examination. Anæmia may or may not be present in benign tumors, but is marked and progressive in sarcoma. Emaciation occurs when vomiting is severe, and is serious in all cases of sarcoma.

Epigastric tenderness, sometimes visible and audible peristalsis will be noted, especially just before and during the paroxysmal pain. A palpable abdominal tumor has not often been found. In our case, it could be felt when the patient lay on her left side, but was not detected when she lay on her back.

Thus it is obvious that symptoms are those of disease in stomach or duodenum. Röntgen-ray examination is always called for, and by this means the diagnosis ought invariably to be made. Moreover, it is possible to make a differential diagnosis between tumor, ulcer, cancer and diverticulum of the stomach and duodenum.

Röntgen-ray characteristics are fairly definitely established. Usually the stomach examination is quite negative. As a rule, there is no six-hour residue; in the presence of marked atony of the stomach, and secondary anæmia, the stomach may be dilated, and often peristalsis is increased. There is regularly a filling defect in the duodenum. This defect may be circular, oval, vacuolar, or multilocular. It will show as a ring of barium around a translucent filling defect. The duodenal cap may or may not be dilated, and cannot be filled completely. A multilocular defect is suggestive of papilloma and a vacuolar defect is suggestive of adenoma or sarcoma. The defect is best shown with the patient in a right oblique position, though it is noted also in an upright and prone position, but frequently cannot be seen with the patient lying on the back. The deformity may easily escape observation upon fluoroscopical examination. Numerous films must be made in various positions to get the finest details of the appearance of the bulb.

The filling defect, especially when accompanied by dilatation of the duodenum, constitutes a reasonable basis for diagnosis of tumor, as distinguished from ulcer and diverticulum.

The differential diagnosis must be made from all diseases characterized by upper abdominal distress and indigestion, and must be borne in mind in considering the cause of any case of anæmia. Peptic ulcer, gall-bladder disease, carcinoma of the stomach, or pancreas, benign tumors on the stomach side of the pylorus, prolapsed into the duodenum, these lesions constitute the diseases from which differential diagnosis must be made. The problem of diagnosis is for the röntgenologist.

Summary and Conclusions.—(1) Benign tumors and sarcomas of the duodenum are extremely rare. One case of metastatic sarcoma of the duodenum is reported, three cases of sarcoma and thirty-two cases of benign tumors of the duodenum have been collected.

(2) The disease has been found at various ages, from eleven days to seventy-five years of age.

(3) Tumors of the duodenum are associated with tumors in other parts of the intestines, in ten out of thirty-six cases recorded.

(4) The symptoms are those of "stomach trouble"; recurrent epigastric pain, progressive loss of appetite, with nausea and usually vomiting, sometimes vomiting blood, often the passage of blood from the bowel, and progressive anæmia, weakness and emaciation, all more marked in malignant disease.

(5) Differential diagnosis is from pernicious anæmia, peptic ulcer, cancer, diverticulum, and from pedunculated tumors located in the stomach and prolapsed into the duodenum. This differential diagnosis can be made by properly conducted Röntgen-ray examination.

(6) The treatment for tumors of the duodenum is excision of the duodenum, and anastomosis of the stomach to the duodenum by the Haberer or Finney method.

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DOUBLE PRIMARY MALIGNANT TUMORS OF THE COLON

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The presence of more than one malignant tumor of an organ simultaneously, while uncommon, has a special pathological and surgical interest. Multiple malignant tumors of the skin are not considered unusual, and the polyposis of the rectum and sigmoid with several malignant areas are pointed out as examples of simultaneous primary malignant tumors. They are by all odds the outstanding example of the possibility of such a manifestation. Bargen and Rankin[1] have dealt with it fully when they say:

> Multiple primary malignant lesions in various tissues in one person, occurring at the same or widely separated periods of time, have been frequently recorded. Similar malignant tumors occurring in the same organ at the same or different times, have rarely been described. Carcinomata of a hollow viscus that are essentially alike or closely related and that are distinctly separate primary malignant lesions are rare but probably they are not as infrequent as formerly has been supposed. . . . That this fact has a bearing on treatment and prognosis needs no further comment.
>
> Taking up individual organs or even systems, the number of cases of proved multiple primary foci is a small one, but doubtless many cases have been observed but not reported.
>
> Major[2] has made an exhaustive study and classification of multiple primary malignant tumors. In nine cases he found they were in the organs belonging to the same system.
>
> Norbury[3] believes there is more close relation between multiple adenomata and cancer of the rectum and colon. He says: "At any period in the development of an adenoma the epithelium may assume invasive properties, and the tumor becomes a carcinoma. Such a carcinoma may therefore be regarded in the light of an accidental happening in a previously existing adenoma."
>
> In order to establish the individuality of the growths present, certain requirements have been suggested, the fulfillment of which is necessary to eliminate the possibility of metastasis. This is not always possible, although clinically there may not exist the least doubt about the tumors being unrelated.
>
> Miller[4] discusses this phase of the clinico-pathological side of the question. He reports five cases: in three, carcinomata was present in the colon simultaneously and in the remaining two cases an interval of considerable time elapsed between the development of the tumors in the bowel. He notes the difficulty in establishing the individuality of simultaneous growths and questions the practical application of Billroth's formula as a criterion of the proof of the independence of each growth.

Billroth is credited with having laid down these requirements:

(1) The two growths must show distinct histological differences and must be so pronounced as to exclude their interpretation as merely different stages of development.

(2) Each growth must have its own group metastasis.

(3) Each growth must originate from its own epithelium.

Mercanton adds a fourth requirement:

If both growths are removed at operation and recurrence does not follow, it carries the conviction that each growth was primary.

This is a requirement that is difficult to fulfill, inasmuch as it necessitates the cure of the patient with two malignant growths in the same organ.

The question of metastasis is the one which projects itself into the discussion, because we cannot formulate a test by which a metastatic growth is positively identified. We have accepted opinions concerning the channels by which a new field may be invaded, but we do not know if there are not some exceptions. There are very strong reasons for believing that obstruction of a lymphatic duct may be the cause of a metastatic growth in a wholly unexpected organ or tissue, and dissemination by the blood-stream seems to be the only logical explanation of some carcinomatous deposits.

While the discussion of primary and secondary carcinomata in the same organ or system is a fertile field for speculation and research, the clinical side must always appeal to the surgeon as the more interesting and important, as the immediate recovery and permanent cure depend on the operative judgment and mechanical ability.

The infrequency of two simultaneous malignant lesions in an organ has naturally made the search for such a condition, both before and during operation, not a matter of routine, and such cases are found by accident rather than by diligent effort. Fenger[5] had such an experience, probably the first double carcinoma of colon reported in this country (1888).

A surgeon can never be so mentally versatile that he will be familiar with all the possibilities which may be unfolded by the open abdomen. This applies equally as well to the röntgenologist and internist. There is little wonder, then, that in the literature concerning multiple malignant tumors of the colon, we find the failure of a colostomy to relieve an obstruction the first inkling of the presence of a second obstructing growth. Cabot[6] made the diagnosis of double carcinoma in a case and prepared to do two resections, separated by a reasonable period of time. The patient succumbed a few days after the first stage operation. The patient was a bad risk, having anæmia, syphilis, enlarged liver and enlarged spleen.

How this oversight may be prevented may appear simple; namely, institute a routine examination of the colon in all cases, even when a single malignant tumor is definitely located prior and during the operation. But with the accuracy of the X-ray, the insignificant number of multiple growths, and some mechanical difficulties that present themselves in exploration, it would seem that such a critical examination of the colon would seem unnecessary or impossible in every case. It does not seem practical to formulate a procedure that would pick up the rare case without enforcing a hardship, economic or otherwise, on the immense majority of patients having but a single tumor. We can only suggest, from a most limited experience, that those cases from a röntgenological standpoint, that present any variation from the typical maligant obstruction should be carefully re-studied, and at operation the examination of the entire colon should be undertaken if possible.

FIG. 1.

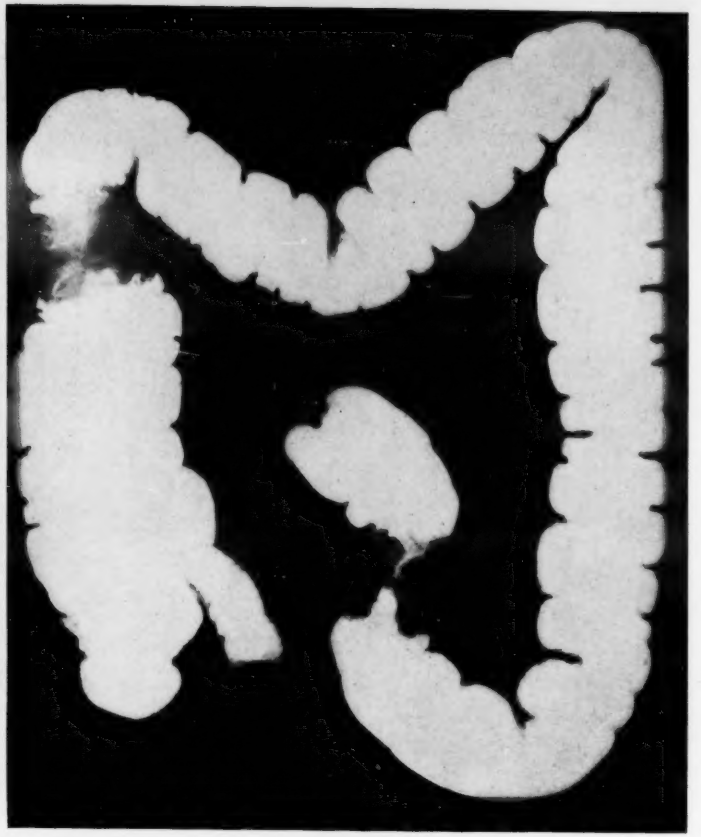

FIG. 2.

FIG. 1.—A barium enema showed a very definite obstruction at the hepatic flexure. This obstruction was almost complete, with slight canulization and irregular filling defects, very typical of an ulcerating malignancy. A few days later, when another diagnostic barium enema was given and the patient was examined under the fluoroscope, considerable difficulty was noted in the enema passing the sigmoid area. Because of the long, redundant sigmoid, no direct view could be secured of the obstructed area. The malignant obstruction at the hepatic flexure was still quite evident. These conditions were reported to the surgeon at the operating table before incision.

FIG. 2.—About two weeks later, after colectomy had been done, the entire specimen removed was filled with barium. At this time the obstruction in the sigmoid was complete, and that at the hepatic flexure almost entirely so.

This is just another way of stating that we *hope* to recognize the next case of this type that may come under our care.

The following case appears to us to be undoubtedly one of double primary adenocarcinoma of the colon:

CASE.—C. S., male, thirty-seven years of age, was referred by Dr. W. J. Mallory, who furnished the following history:

First seen February 12, 1930. Thirty-five years of age. Height 5 feet seven inches, weight 130 (should be 150). Temperature 98.4°, pulse 88, blood-pressure 120/75. Pain in the lower abdomen intermittent recurring about every three minutes, not affected by food. Constipation and loss of weight. This pain began about six weeks previously. The pain is not relieved by food, laxatives, belching of gas, soda, or rest. It occurs both night and day. Appetite is good. Sleep is interrupted by pain. Bowels constipated moderately, but relieved by mineral oil. He has lost five pounds in six weeks. The family history presents no information relative to his present illness.

Physical examination.—Nervous system negative. Gums apparently healthy. Tonsils have been removed, there are no tags remaining. The epitrochlear glands are palpable. Heart and lungs clear. The abdominal organs are not palpable. No localized tenderness, tumors, or muscle spasm.

Laboratory examinations.—Test breakfast.—30 cubic centimetres. Free hydrochloric acid 24, total acidity 32. Benzidine negative. Microscopically negative.

Urine, February 14, 1930, straw, clear, acid, 1018. Sugar negative, diacetic plus. Microscopically, occasional oxalate, no pus, no casts. Fæces, February 14, 1930, soft, unformed, well digested, slight fermentation, streaks of bright red blood. Benzidine inky, guiac 3 plus, microscopically negative.

Fluoroscopy, lungs appear normal, other than moderate fibrosis about the hila. Heart for type of individual seems broad. Stomach slightly low but normal in every other respect. Duodenal cap well visualized and appears normal. No six-hour residue, a peristaltic rush across transverse colon. At twenty-four hours the entire colon visualized. Cæcum freely movable, transverse colon slightly spastic, sigmoid appears normal. The rectal pouch is drawn.

When seen March 9, 1932, the patient presented the usual signs of an incomplete intestinal obstruction, involving the large bowel. Moderate distention was present but no mass could be palpated.

An X-ray examination (Fig. 1) made March 2, 1932, was reported. *Diagnosis.*—Indeterminate. Obstruction at hepatic flexure. (Fig. 2.) Cause (?).

X-ray examination March 5 determined a diagnosis of annular carcinoma of the colon at the hepatic flexure.

Operation March 9, 1932, a long right rectus incision disclosed a large nodular mass in the hepatic flexure of the colon. Further exploration of the abdomen revealed an equally large mass in the sigmoid of the same nature as the one in the hepatic flexure. An ileocolostomy was done, with a loop of the ileum about twelve inches from the cæcum at the rectosigmoid junction. The post-operative convalescence was without note except slight superficial infection in the wound.

Two weeks later a second operation was undertaken; the patient was transfused at the same time; owing to the infection in the primary wound, the incision was made in the left rectus, and it proved to be disadvantageous, owing to the inaccessibility of the growth in the hepatic flexure. The immobility of the colon at this point made its removal somewhat difficult. The entire colon with about six inches of the ileum was removed. The patient had moderate but not alarming shock and progressed well until the fourth day, running a rather rapid pulse, moderate elevation of temperature, but vomiting was never present. On the evening of the fourth day, he became restless, pulse further accelerated and further elevation of temperature. He died the following day. X-ray examination of

FIG. 2.—About two weeks later, after colectomy had been done, the entire specimen removed was filled with barium. At this time the obstruction in the sigmoid was complete, and that at the hepatic flexure almost entirely so.

the chest on third day after second operation showed some pulmonary congestion and œdema, but hardly sufficient pathology to explain the high temperature and rapid pulse of the patient. Permission for autopsy was refused, but death was probably due to

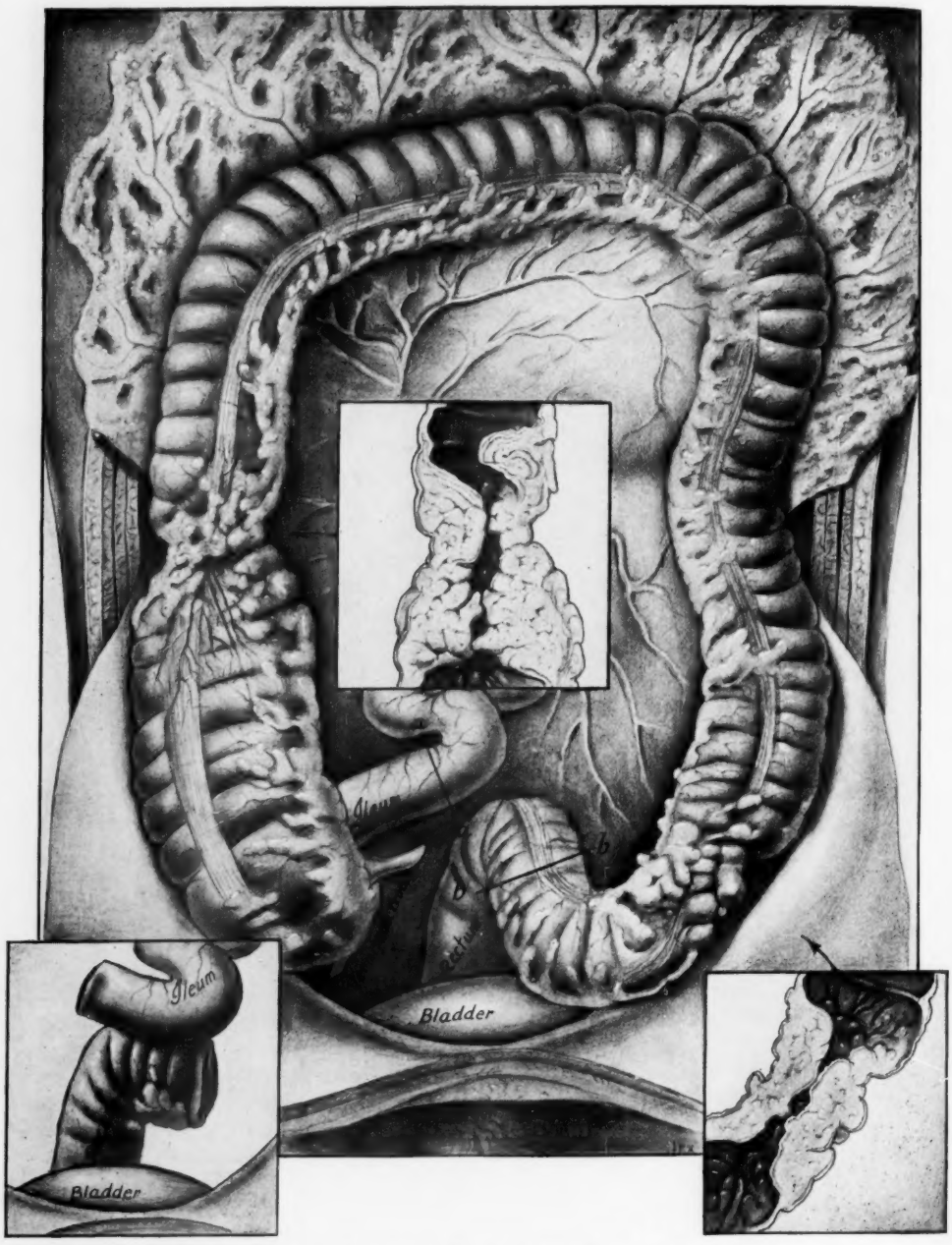

FIG. 3.—Shows malignant growths at hepatic flexure and in sigmoid.

peritonitis. Laboratory reports.—March 5, red blood-cells, 4,060,000; white blood-cells, 11,790; hæmoglobin, 72 per cent. Urine showed a faint trace of albumen and a few hyaline casts. The Wassermann was negative. On March 22, the day prior to the

second operation, the blood was reported as follows: red blood-cells, 3,600,000; white blood-cells, 11,800; hæmoglobin, 45 per cent. The urine on the same day showed a few hyaline and few granular casts.

Comment.—Multiple malignant growths of the colon are unusual, but probably not as infrequent as statistics would indicate. An X-ray pre-operative diagnosis is possible, but it would not be made in the routine examination of the colon unless the röntgenologist possessed some uncanny diagnostic ability. It is possible that further X-ray study of the atypical obstruction may lead to the recognition of multiple malignant lesions. In view of the fatality in our only case, it may be proper to consider a double resection or even operation in three stages better surgical judgment.

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ACUTE OBSTRUCTION OF THE DUODENUM DUE TO SUBMUCOUS HÆMATOMA

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The retroperitoneal fixed position of the duodenum gives it an immunity to acute obstructions caused by twists, bands, or invaginations, except at its junction with the pylorus or with the jejunum. The following case is deemed worthy of being reported because of the rarity of acute duodenal obstruction and the very unusual etiology found. Duodenal stenoses caused by congenital membranes or septa, scarring from ulcers, benign and malignant tumors either intrinsic or extrinsic, external bands, pressure of the mesentery containing the superior mesenteric vessels, or impaction of foreign bodies, though rare, are well-recognized entities. Infrequent cases of acute obstruction have followed gastroenterostomy, acute impaction of gall-stones or other foreign bodies, and retroperitoneal hæmorrhage. In 17,652 autopsies at the Guy's Hospital, there were only seventeen cases of chronic and acute obstruction of the duodenum.[1]

The relation of acute dilatation of the stomach to duodenal obstruction is not clear. Corroborating the findings of Novak,[2] Dragstedt, Montgomery, Ellis, and Matthews[3] comment on the absence of dilatation of the stomach in those cases of very high intestinal obstruction that have been reported as a result of various causes. In the case here reported, extreme gastric dilatation could be attributed to either of two causes, duodenal obstruction or acute pancreatitis, or possibly their combination.

L. K., No. 303587, a married woman of forty-two years, born in the United States, a laundress by trade, was admitted June 14, 1929. Her past history was negative except for a mastoidectomy five years previously and an abscess of the right side of her face fifteen years previously. She was well until three weeks before admission when she had an attack of colicky pain, peri-umbilical in location, associated with vomiting but with no constipation. These symptoms disappeared completely after about four days. Four days before admission she was suddenly seized again with colicky pains in the epigastrium and peri-umbilical region which persisted and were very severe. Continuous vomiting had been present until five hours before admission. She had no bowel movements but had passed flatus. Gaseous eructations were present. The abdomen had become markedly distended; there were no urinary symptoms. She was an extremely obese woman. She lay in a state of marked shock with cold clammy skin; her temperature was 100.4°; pulse, 120. The abdomen was markedly distended, perhaps more in the left upper quadrant than elsewhere; shifting dullness was noted. Tenderness was present all over the abdomen and most marked in the upper quadrants, especially in the epigastrium; there was also moderate rigidity in the upper quadrants. An indefinite mass seemed to occupy the left upper quadrant but no other details could be made out. Vaginal examination was negative. Rectal examination was negative; the presence of fæces was noted. The rest of the physical examination was negative.

The blood count showed: white blood-cells, 31,000; polymorphonuclear leucocytes, 88 per cent.; lymphocytes, 8 per cent.; mononuclears, 4 per cent. The urine was negative. The blood-pressure was 110/90.

Abdominal X-ray examination showed no unusual dilatation of the gut by gas. The entire abdomen was obscured by a homogeneous shadow of moderate density which suggested the presence of fluid. Stimulating measures including intravenous infusion were employed to bring the patient out of shock before operation. The patient was subjected to operation several hours after admission.

A three-inch right para-umbilical incision was made; on opening the peritoneum a tense, enormously distended purplish viscus was encountered. At first this was thought to be a large ovarian or renal cyst. On tracing it farther, however, the operator found this huge cyst-like mass to extend upward beneath the liver and thence under the left diaphragm. After removal of the examining hand from under the left diaphragm, a moderate amount of bloody, somewhat turbid fluid escaped. It was then recognized that this mass was the extremely dilated stomach. A stomach tube was passed into it from the mouth and a large amount (3,500 cubic-centimeters) of grayish-green, thin fluid resembling pea soup was expressed until the stomach was empty. Upon further exploration, the pyloric ring was felt to be somewhat thicker than normal but admitted a finger. There was some fibrinous exudate on the under surface of the liver surrounding the gall-bladder. The latter, however, was normal except for two small stones. It emptied with ease. The head of the pancreas felt much larger, wider, and firmer than normal. The under surface of the transverse mesocolon showed several irregular hæmorrhagic areas measuring three by two centimeters in the centre of which were several flat grayish-white lesions which had the appearance of fat necrosis. There was a similar hæmorrhagic area seen on the superior leaf of the mesentery. The uterus contained a few small fibroids and the adnexa were normal. The first and second parts of the duodenum were palpated but no obstructive lesion was detected. The impression was that we were dealing with an acute pancreatitis with fat necrosis with reflex acute gastric dilatation as no obstructive lesion was found. A rubber dam drain was placed in the foramen of Winslow.

Post-operative Notes.—At the termination of the operation the patient was in extremely poor condition. Stimulating measures were administered but she failed to rally and died thirty minutes after the close of the operation.

Necropsy June 14, 1929: Thorax, negative.

Abdomen.—About 1,000 cubic-centimeters of thin yellow-brown fluid are found in the left upper quadrant beneath the diaphragm. The stomach is remarkably dilated and its serosal surface is red and dull. At the root of the mesentery both in the region of the caput coli and the right kidney there are red areas of retroperitoneal hæmorrhage.

Liver.—Normal. The gall-bladder contains fifty cubic-centimeters of green bile and two small calculi, one centimeter in diameter. The common bile-duct is patent and shows slight dilatation which extends into the intrahepatic bile-ducts. The portal vessels are negative.

Pancreas.—Large, measuring 15 by 3½ by 2½ centimetres. It appears swollen. The surface shows numerous spots of fat necrosis and is slightly injected throughout. There is a small hæmorrhagic area in the head of the pancreas. Cut sections present numerous areas of fat necrosis throughout the organ. The pancreatic lobular structure is well-preserved and brown in color. There is a rather sharply circumscribed tumor the size of a hazel-nut at the head of the pancreas. It is firm, grayish-white and fibrous in appearance. In its centre there are several lumina, apparently dilated ducts, varying in size, which are filled with grayish thick mucus. The duct of Wirsung opens into the ampulla of Vater. It is slightly narrowed at its opening into the duodenum.

Duodenum.—The second portion appears hæmorrhagic. On opening the duodenum anteriorly, one sees a tremendous submucosal hæmorrhagic infiltration involving its entire circumference, beginning about six centimetres from the pylorus and extending to about

the junction of the second and third portions of the duodenum. At the region of the head of the pancreas this infiltration forms a large hæmatoma about the size of a tangerine orange which fills the duodenal lumen and completely obstructs it. Above the hæmatoma the duodenum and stomach are found to contain a large amount of greenish bloody fluid.

Stomach.—The stomach is greatly dilated and filled with greenish bloody fluid. The mucosa is hæmorrhagic, especially that of the greater curvature. At the lesser curvature, near the cardia, there is a large ulcer measuring 4½ by 10 centimetres. The base of the ulcer is paper thin and apparently composed only of serosa. Its borders show no reaction. The lesser curvature externally over this ulcer is covered with fibrinous material.

Œsophagus, small intestine, and *large intestine* are essentially negative except that the contents below the duodenum are seen to be composed of thin, watery, clay-colored stools with a peculiar silver-grayish sheen to them.

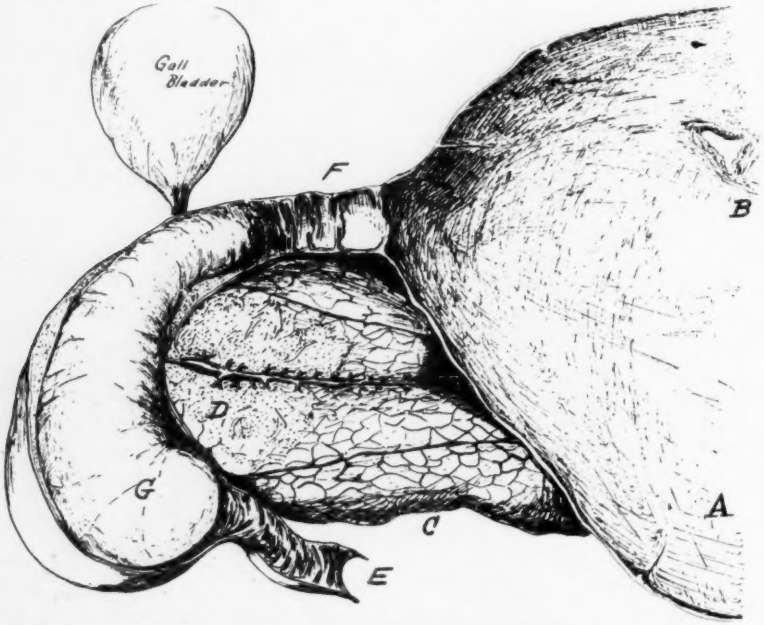

FIG. 1.—Semi-diagrammatic sketch of post-mortem specimen. *A*—Stomach; *B*—Tension ulcer; *C*—Pancreas; *D*—Location small adeno-carcinoma head of pancreas; *E*—Third portion duodenum; *F*—First portion duodenum; *G*—Submucous hæmatoma of duodenum.

Microscopical Examination.—Pancreas.—There are many small bluish areas in which the acinal cells show necrosis and necrobiosis. The interlobular septa show an infiltration with polymorphonuclear leucocytes. Within the head of the pancreas are islands of cylindrical and irregularly shaped cells which frequently form pseudo-glands. They have the typical appearance of an adeno-carcinoma.

Duodenum at the level of the pancreas shows a large submucous hæmatoma. There are islands of infiltrating adeno-carcinoma in the duodenal wall.

One of the paratracheal lymph-nodes shows carcinomatous metastases.

Final Diagnosis.—Adeno-carcinoma of the head of the pancreas infiltrating the duodenal wall with dilatation of the pancreatic ducts and metastasis to a paratracheal lymph-node. Acute pancreatitis. Submucosal hæmatoma of the duodenum with complete obstruction.

Fat necrosis of the pancreas, omentum, and mesocolon.

Acute dilatation of the stomach with tension ulcer and hæmorrhages. Localized acute fibrinous peritonitis. Cholelithiasis.

The diagram (Fig. 1) illustrates the large submucous hæmatoma obstructing the second portion of the duodenum with a huge gastric dilatation. The stomach shows the type of tension ulcer along the lesser curvature which occurs with severe dilatation. Through the serosa overlying it seepage took place causing the peritonitis. The site of the very small carcinoma of the head of the pancreas and the moderate dilatation of the pancreatitic ducts behind it is indicated.

No large bleeding vessel could be found as the cause of the obstructing duodenal hæmatoma. The bleeding may have resulted from the erosion of a small blood-vessel incident to the acute pancreatitis. The latter condition was possibly initiated by rupture of dilated ducts behind the carcinoma which

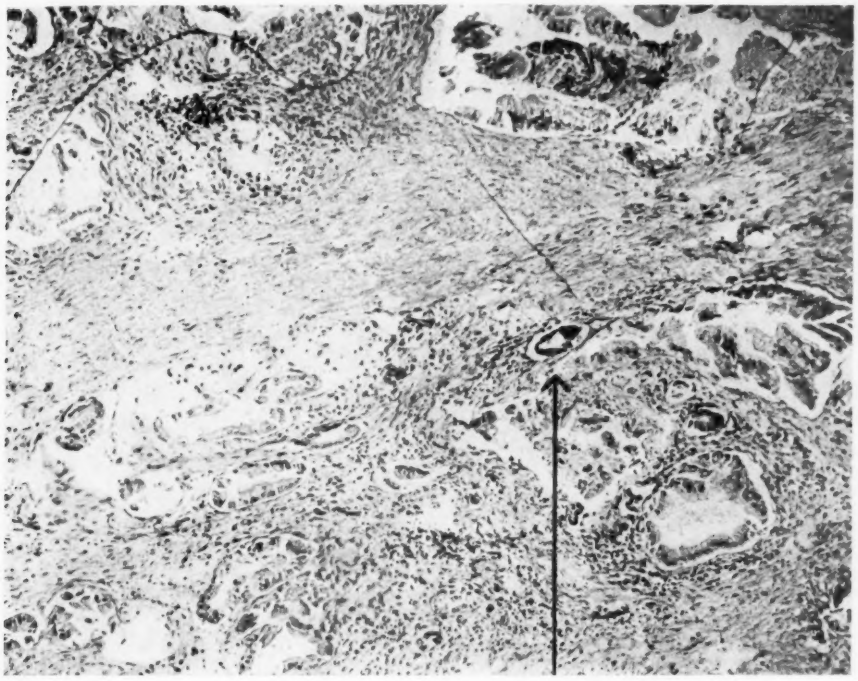

FIG. 2.—Carcinoma cells in duodenal wall.

obstructed them. More likely, however, the bleeding may have come from a vessel in the duodenal wall which was eroded by the infiltrating carcinoma (Fig. 2). At any rate, coincidental with the small carcinoma of the head of the pancreas and acute pancreatitis there developed acute obstruction of the duodenum by a submucous hæmatoma. As a sequel to the obstruction and to the acute pancreatitis the stomach became extremely dilated.

The extent of this dilatation was comparable with that attained in cadavers by Revilliod and Key Aberg,[4] in some experiments reaching 4,000 cubic centimetres. The rupture of the mucous membrane along the lesser curvature at the cardia which occurred in their experiments coincides with the finding in this case. Cases have been reported of rupture of the stomach due to

chronic and subacute duodenal stenosis.[5] Rupture of the apparently normal stomach from overdistension has occurred; the place of rupture has always been along the lesser curvature near the cardia.[5]

The etiology of the acute pancreatitis in this case was apparently the rupture of a dilated duct within the pancreas behind an obstruction caused by the carcinoma in its head.

Interesting from another standpoint was the finding of metastatic adenocarcinoma in a paratracheal lymph-node. This had already become established despite the fact that the primary focus in the pancreas was still very small and had produced no symptoms until the onset of the acute illness.

Only two other cases of duodenal obstruction due to hæmatoma have been found in the literature. The first case[1] was that of a man of twenty-three years admitted to the hospital for an abdominal aneurism attributed to an injury. Death resulted suddenly from its rupture. Besides the large quantity of blood found in the peritoneal cavity, there was much recently coagulated blood anterior to the pancreas and adjacent to the third portion of the duodenum. Here the bowel was so compressed that it would barely admit a finger. The stomach and duodenum were filled with fluid while the jejunum was collapsed. The second case[6] was that of a driver whose abdomen was compressed between two cars. Two hours later he was observed in the hospital where his pulse was found to be 76; there was no vomiting. He had some pain but his general condition was good. On the next day his condition was still good. On the third day he vomited continuously; his stomach seemed to be dilated and his general condition seemed bad. An X-ray examination showed an obstruction between the second and third portions of the duodenum. On the fourth day a laparotomy was performed; the duodenum was found to be pushed forward and to the left by a large retroperitoneal hæmatoma the size of a hen's egg. This was evacuated and the patient made an uneventful recovery.

It is thus seen that the fixed position of the duodenum makes this portion of the gut more susceptible to obstruction from retroperitoneal hæmorrhage than any other portion of the gut. Cases of gall-stone obstruction have been reported. Borchgrevink,[7] Thompson[8] and many others have reported such lesions. Other foreign bodies rarely cause obstruction; they are usually followed by perforation and peritonitis.

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PERFORATED PEPTIC ULCER IN GERMAN CLINICS

AN ANALYSIS OF 4,402 CASES

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The common presence of multiple peptic ulcers in German or Central European patients with perforated peptic ulcer has encouraged the German and Austrian trained surgeons to resect the stomach primarily. Reports in the German literature demonstrate that such radical surgery not only cures most patients of all peptic ulcers present, but is also attended by a surprisingly low mortality rate.

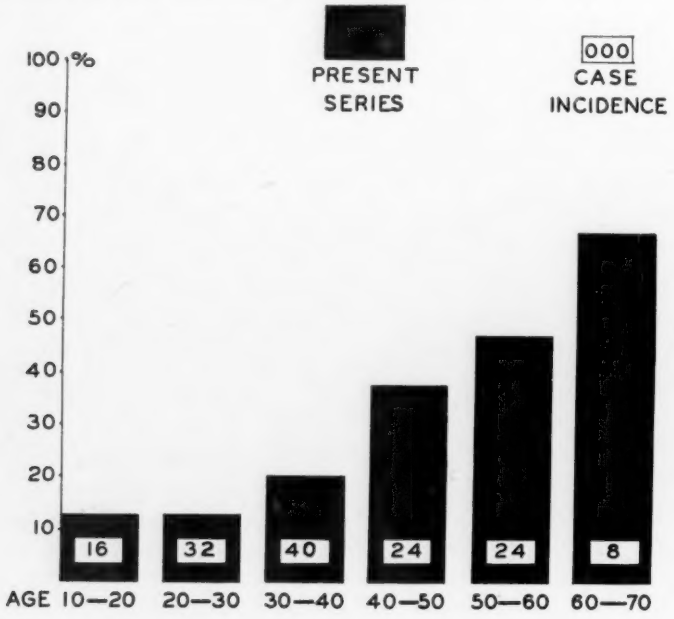
The following study of perforated peptic ulcer and its treatment in Germany and Central Europe is presented believing that it is of interest and not with the intention of encouraging the institution of surgical measures which seem too radical for the successful handling of the usual type of perforated peptic ulcer encountered in North America. It is based on 144 cases personally collected in the University Clinic of Professor Victor Schmieden at Frankfurt am Main. In addition are considered 4,258 cases reported from other clinics of the German or Austrian schools of surgery, making a total of 4,402 cases.

Bauer, Aschner, Brütt, Zukschwerdt and Eck and others believe that there is a hereditary predisposition to peptic ulcer and thus to perforation. That some individuals repeatedly develop perforating peptic ulcers is well known. The perforated peptic ulcer patient in Germany differs from the one often pictured by American authors. He is usually a strong and well-nourished individual who eats excessive amounts of coarse foods, drinks a considerable volume of fluids, and works hard. Various authors estimate that over 60 per cent. of perforations occur in laborers. That 55 to 95 per cent. of these patients give a history of having had ulcer symptoms for days or even years preceding perforation is indicated in reports of Speck, Brütt, Wagner, Kuntz and others. In the present series one-third of the cases had been or were being treated for peptic ulcer, and the records show that 90 per cent. had had symptoms previous to those of actual perforation. Speck, in reviewing the world literature on perforated peptic ulcer, says that 10 per cent. of all peptic ulcers perforate. Hart believes that perforation occurs in 10 per cent. of all patients with duodenal ulcers, and Cukor states that it occurs in 6.5 per cent. of all patients with gastric ulcers and in 25 per cent. of those with duodenal ulcers. Although these percentages are merely estimations, they are probably not far from correct.

Formerly, the majority of peptic-ulcer perforations occurred in women. Brunner, in 1903, and Shoemaker, in 1914, reported incidences of 80 per

cent. and 52 per cent., respectively, in women, but later studies give lower percentages and most of the recent ones contain few or no cases in women. E. Schwarz reports 30 per cent.; Prader, 12 per cent.; Kott, 12 per cent.; Zukschwerdt and Eck, 6 per cent.; F. Schwarz, 8 per cent.; Cukor, 3 per cent.; Schulein, no occurrences in women, and in the present series there were only three cases in women up to 1926 and none since then. This markedly decreasing incidence in women has not been satisfactorily explained.

Perforation of peptic ulcer occurs most frequently in the third and fourth decades of life and the prognosis is more favorable in those under



INCIDENCE AND MORTALITY RATE PERCENTAGES BY DECADES OF LIFE

GRAPH I.—Illustrates the incidence of perforated peptic ulcer and the mortality rate percentages by decades of life in the present series.

forty years of age. (Graph I.) Its occurrence in adolescence is not uncommon, and it has been reported in the aged. Speck observed one perforated ulcer in a patient seventy-seven years old, Schulein one in a patient of seventy-five years, and Kuntz one in a seventy-four-year-old individual.

The time elapsed between ingestion of food and perforation of peptic ulcer is variously given by different authors. Bager found that two-thirds of the perforations occur in the daytime, mostly between four and six P.M., which is three to five hours after eating the main meal, but Brunner observed that 50 per cent. perforate within two and a half hours after eating. That they may occur more frequently in the fall is shown by Brunner, Bager, Zukschwerdt and Eck, but all authors do not concur in this finding.

Eck and Zukschwerdt had one case and quote another, and Eichelter observed two cases in which perforation occurred during röntgenographical examination. Panek, Bundschuh, Steiger, Mandl, Albrecht and others have warned about this danger. In the Schmieden Clinic, one fatal perforation occurred while a patient was undergoing a gastric analysis.

That frequently there is a multiplicity of peptic ulcers in German patients with perforated peptic ulcer is a proven fact. Not uncommonly one or more of the additional non-perforated ulcers are chronic penetrating ones. (Fig. 1.) Ulcers are multiple, according to Brunner, in 32 per cent.; Speck, 50 per cent.; Schulein, 20 per cent.; Prader, 25+ per cent.; Brütt, 43 per cent.; Hart, 38 per cent.; Gruber, 48 per cent.; E. Schwarz, 26 per cent.; Eichelter, 30 per cent.; Enderlen and Redwitz, 20 per cent.; Petren, 27 per cent.; Neumann, 40 per cent.; and Zukschwerdt and Eck,

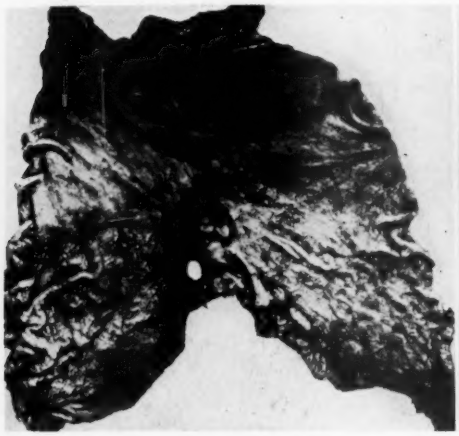


FIG. 1.

FIG. 2.

FIG. 1.—Perforated ulcer of lesser curvature of stomach, multiple small gastric ulcers and old ulcer scars in pyloric area.
FIG. 2.—Large calloused ulcer of lesser curvature.

29 per cent. Although the older records of the Schmieden Clinic do not show a high incidence of multiplicity of peptic ulcer, it would seem from later records and from personal observations that 30 per cent. is not too high a general incidence of multiplicity. The ulcers that perforate are usually the large, calloused ones (Fig. 2) occurring in a stomach that shows atrophic (Fig. 3) or hyperplastic (Fig. 4) changes of a long-existing gastritis. Perforations are occasionally as large as three centimetres in diameter and not infrequently they are one centimetre in diameter. Simultaneous perforation of two peptic ulcers is not unknown. Brunner found eight instances, Zukschwerdt and Eck report one case, and from the Schmieden Clinic the author adds two more. Shoemaker's estimate that there are double perforations in 3 per cent. of cases is probably too high.

Statistics collected from the literature indicate that perforated ulcers are as common in the stomach as in the duodenum and that mortality rate for both is approximately the same. However, the author agrees with Eichelter, who believes that these studies are subject to error and states that

70 per cent. occur in the duodenum or pyloric area. Exact localization of the perforation at the time of operation is often difficult. Findings are not infrequently incorrectly recorded and some authors consider the pyloric area as stomach while others class it as duodenum. In the present series, there were recorded four perforations in the cardia, thirty-four in the stomach, forty-one in the pyloric area, and sixty-five in the duodenum. The mortality rate was 26 per cent. for those occurring in the duodenum and the pyloric area, 38 per cent. for those in the stomach, and 50 per cent. for those in the cardia. It is regrettable that there are no large series which are of real value in determining the mortality rates for different sites of perforation.

The justification for surgery in cases of perforated peptic ulcer was

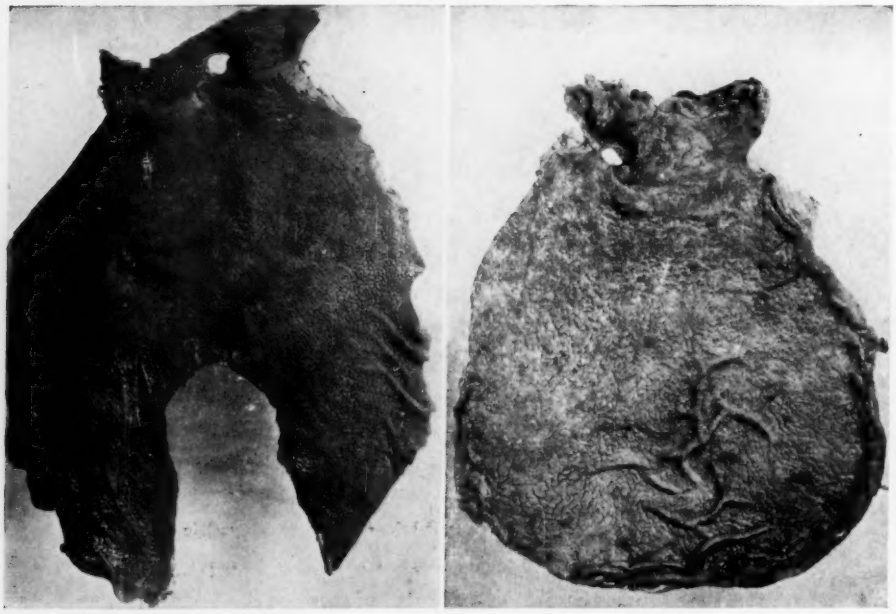


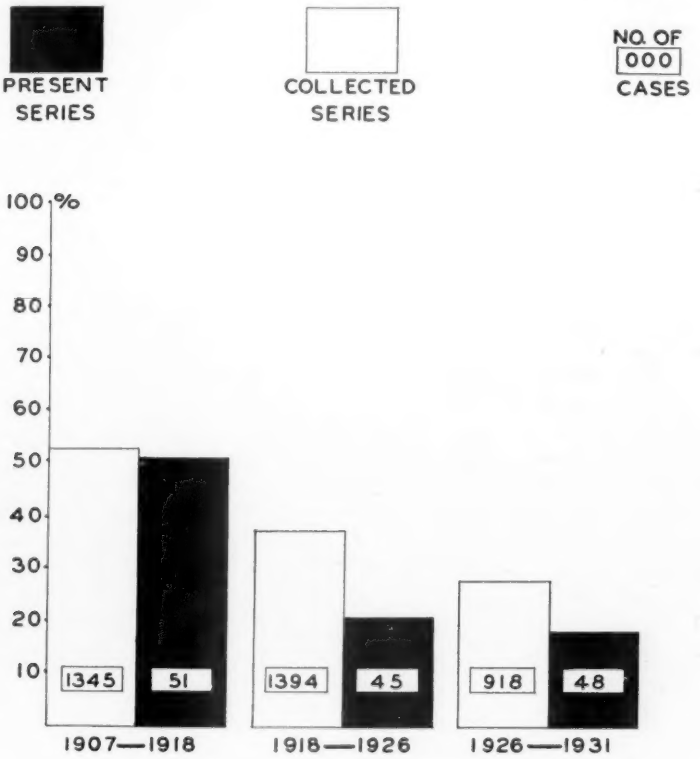
FIG. 3. FIG. 4.

FIG. 3.—Perforated ulcer in the duodenum and atrophic gastritis.
FIG. 4.—Perforated ulcer and old ulcer scars in the pyloric area. Stomach mucosa is hyperplastic.

demonstrated by the successful operations of Heussner and Roux in 1892, twelve years after Mikulicz had failed in the first case ever operated upon. In 1897, Mikulicz collected 103 surgically treated cases in which there was a mortality rate of 68 per cent. Brunner, in 1903, collected the first large series, one of 387 cases, with a mortality rate of only 48 per cent., but he called attention to the probability that only the better results were being reported and expressed the belief that the true mortality rate was about 68 per cent.

That immediate surgery is the method of choice in the treatment of perforated peptic ulcer is demonstrated in Graph II, which shows for the present series a mortality rate that decreased for successive intervals of time from 50.9 per cent. (1907 to 1918) to 20 per cent. (1918 to 1926),

and finally to only 16.6 per cent. (1926 to 1931). It will be noted that in the collected series, there is a corresponding decrease (Graph II) when these are grouped into the same periods of years, but it is not so evident when individual series (Table I) are studied. The discrepancy is due to series that begin many years prior to reporting. This decrease can be attributed in part to improvement in technic and more correct diagnoses, but mainly to the system of the practice of medicine on the continent. More than the majority of Germans are compelled by law to carry sickness insur-



GRAPH II.—Shows the number of patients operated upon and the decreasing mortality rate percentages in the present and collected series by periods of years.

ance in the indirectly governmental controlled Krankenkassen, which have become very powerful. The requirement for economies from such organizations has resulted in fewer hospitals, but these are large, well equipped, well staffed, and are either under the direction of university medical schools or men who have been trained for fifteen to twenty years in university clinics. A patient with symptoms of any severity immediately calls a physician whose fee is paid by the Krankenkasse, and thus an early diagnosis becomes the rule rather than the administration of home remedies.

TABLE I

Table Illustrating the Decrease in Mortality Rate Percentage by Years for the Collected Series. The Number of Each Operation Used and the Mortality Rate Percentage for Each Are Indicated

Author	Year Reported	No. of Cases	Mortality Rate Percentage	Operation Used and Mortality Rate Percentage
Mikulicz.....	1897	103	48	
Brunner.....	1903	387	48–68	
Neumann.....	1913	31	55	15 sutured, 60%; 3 closure and G-E, 66.6%; 13 by own catheter method, 48%
Wagner.....	1913	15	40	12 sutured, 33.3%; 3 closure and G-E, 66.6%
Seidel.....	1913	25	28	all sutured
Shoemaker.....	1914	784	48	suture; closure and G-E
Schulein.....	1921	21	47.6	suture; closure and G-E
Noetzel.....	1921	26	40	suture; closure and G-E
Brütt.....	1921	140	40	suture; closure and G-E; 12 resections, 33%
Cukor.....	1921	34	29.5	all sutured
Schmidt.....	1921	19	16	11 sutured; 8 closure and G-E
Wagner.....	1922	46	44	suture; closure and G-E
Zoepfel.....	1922	37	40	suture; closure and G-E; 20 resections, 25%
Roepke.....	1922	19	16	closure and G-E in all
Steichele.....	1923	53	59	closure and G-E in all
Speck.....	1923	105	42	33 sutured, 54.5%; 62 closure and G-E, 32.2%
Blumenthal.....	1923	557	40	suture; closure and G-E
Novak.....	1923	20	30	17 sutured; 3 closure and G-E
Mulleder.....	1923	18	28	1 sutured; 17 resections, 29%
Brütt.....	1923	25	12	suture; closure and G-E; 10 resections, 30%
Engelsing.....	1924	38	26.3	suture; closure and G-E
Eichelter.....	1925	27	63	suture; closure and G-E
E. Schwarz.....	1925	57	54.3	32 sutured, 70%; 20 closure and G-E, 40%; 5 resected, 20%
Amberger.....	1925	57	37	suture; closure and G-E
Abrahamsen....	1925	85	20	all methods
Naumann.....	1926	126	62	suture; closure and G-E
Muhsam.....	1926	116	48	27 sutured, 48%; 51 closure and G-E, 37%; 35 Neumann method, 63%
Kott.....	1926	86	47.6	suture; closure and G-E; 13 resections, 7.9%
Kuntz.....	1926	54	33.3	9 sutured and jejunostomy, 90%; 36 closure and G-E, 22.2%; 2 sutured, 100%; 7 resections, 0%
Oderwalt.....	1926	23	44	6 sutured, 17%; 15 closure and G-E, 0%; 1 resection, 0%
Iacobovici.....	1928	44	52	14 sutured, 79%; 14 closure and G-E, 50%; 16 resections, 32%

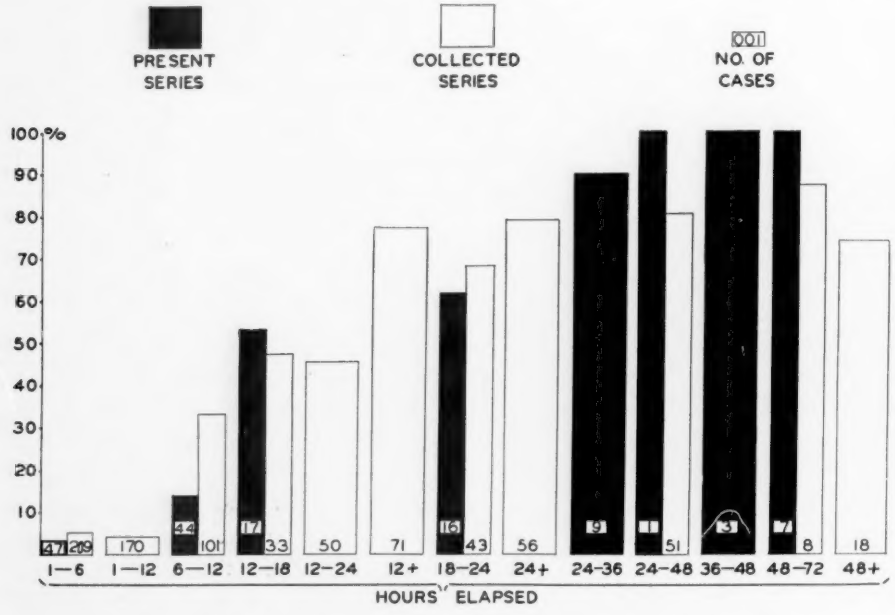
TABLE I (*Continued*)

Author	Year Reported	No. of Cases	Mortality Rate Percentage	Operation Used and Mortality Rate Percentage
F. Schwarz.....	1928	58	1.7	24 sutured; 34 closure and G-E; all operated on within 6 hours
Burke de la Camp	1929	19	36.5	7 closure and G-E, 50%; 5 resections, 0%
Willich.....	1929	70	28.5	38 sutured, 29%; 25 closure and G-E, 20%; 7 resections, 59%
Rapant.....	1930	78	27	51 sutured; 2 closure and G-E; 25 resections, 12%
Zielke.....	1930	42	26.2	suture; closure and G-E
Kárpáti.....	1930	151	23.8	suture; Neumann method
Eichelter.....	1930	51	23.5	suture; closure and G-E; 41 resections, 17%
Present Series...	1907–1918	51	50.9	19 sutured, 52.6%; 32 closure and G-E, 50%
Present Series...	1918–1926	45	20	5 sutured, 60%; 16 closure and G-E, 12.5%; 24 resections, 16.6%
Present Series...	1926–1931	48	16.6	7 sutured, 57%; 21 closure and G-E, 14.2%; 20 resections, 5%
Total.....		3,791		

That early diagnosis and subsequent immediate operation favors a successful result is demonstrated in Graph III, which shows a mortality rate of less than 4 per cent. for perforations operated upon within six hours and a rapidly mounting rate which is in proportion to the delay. But one must not base a prognosis only on time elapsed from perforation to operation; it depends upon the general condition of the patient and this in turn depends largely upon the amount of peritoneal contamination that has occurred. Not infrequently, a perforation may be walled off, plugged, or covered over by a neighboring viscus for a period or a multiplicity of periods of time and thus contamination of the abdominal cavity may have occurred only for a relatively short time in a patient whose ulcer perforated twelve to twenty-four hours previously. It is such intermittent patency that makes feasible radical surgical procedures on many patients who would be classed as hopeless risks were the prognosis dependent on time elapsed alone.

The mortality rate percentages for any given operative procedure in the present series and in the collected cases are likely to lead to false deductions. (Graph IV.) No one doubts that closure by simple suture of the perforated ulcer is the easiest and quickest operation to perform and offers the best chance of bringing the patient successfully through the immediate threatening complications, but in most German clinics this operation has usually been performed only on patients who have been in extremely bad condition and more radical operations were reserved for patients who have

been fair to good risks. Thus the mortality rate percentage attending this simple operation is very high, 58 per cent. in the present series, and 50 per cent. in the collected series. (Graph IV.) The only reported series in which simple suture of the perforation was done in all cases were those of Seidel and Cukor, whose mortality rates were 28 per cent. and 29.5 per cent., respectively. (Graph IV.) It would be unfair to depreciate the value of simple closure on the basis of these two old and relatively small series. But simple suture of the perforation did not often cure the almost ever-present gastritis or additional ulcers, so the German surgeons soon began adding a gastroenterostomy. As gastroenterostomy was no doubt performed on patients who were better risks, it was accompanied by a lower



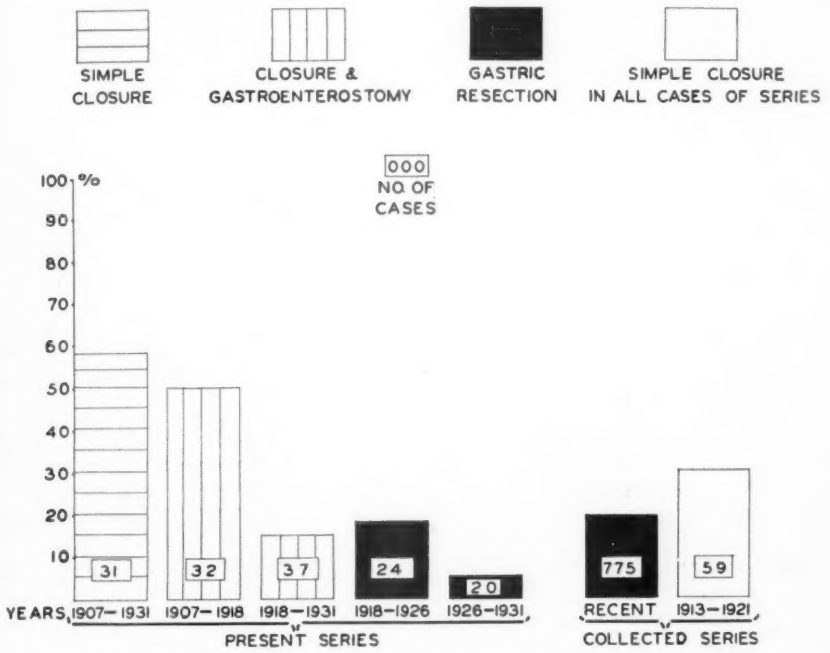
PERCENTAGE MORTALITY RATES ACCORDING TO TIME ELAPSED FROM PERFORATION TO OPERATION

GRAPH III.—Illustrates that the mortality rate per cent. increases in proportion to the number of hours elapsed from the time of perforation to that of operation.

mortality rate and for a while was considered the operation of choice. It will be noted that in the more recent group (1918–1931) of the present series (Graph IV), it is attended by a mortality rate of only 13.8 per cent. Apparently, this procedure resulted in more permanent cures, but many German surgeons pointed out the danger of leakage from the closed perforation and hæmorrhage from other ulcers and objected to the non-removal of the frequently diseased ulcer-bearing portion of the stomach. Ultimately, a high percentage of the gastroenterostomized patients were reported to have required re-operation for gastrojejunal ulcers or non-healed or recurring peptic ulcers.

Before the World War, partial gastric resection had become the method of choice in the treatment of non-healing, non-perforated peptic ulcer, and following the war its use in the treatment of perforated peptic ulcer became popularized. Gastric resection constitutes about one-fourth of the major surgery done in Germany, and, therefore, most German surgeons do this operation skilfully and almost routinely in from forty to sixty minutes. It was found that gastric resection was technically easier to do in most perforated ulcer cases than in elective non-perforated ones, the majority of which are made difficult by the presence of adhesions or penetration of the ulcers into a neighboring viscus.

That gastric resection in patients with perforated peptic ulcer is attended



MORTALITY RATE PERCENTAGES IN DIFFERENT TYPES OF OPERATIONS

GRAPH IV.—Shows the number of simple sutures, closures with gastroenterostomy, and partial gastric resections performed in different periods of years and the mortality rate percentages in the present series. A collected series of partial gastric resections and two in which simple suture was performed in all cases are also shown.

by a remarkably low mortality rate is undeniable. The mortality rate in 775 collected cases is only 18.2 per cent. (Graph IV, Table II.) This is probably due in part to selection of the better risks for gastric resection, but in 156 collected cases in which selection is admitted the mortality rate is only 5 per cent. (Table II.) The mortality rate percentages for gastric resection in the present series are remarkable in that there is little evidence of selection of cases. In the twenty-four gastric resections done in the period from 1918 to 1926, the mortality rate was 16.6 per cent., but in the group

of twenty done in the period from 1926 to 1931, it was only 5 per cent. (Graph IV.) In this latter group, the average number of hours elapsed between perforation and operation was nine, which is exactly the same as that for the 1918–1931 gastroenterostomized group (Graph IV) in which there was a mortality rate of 13.8 per cent. As previously mentioned, the condition of the patient is not governed entirely by the number of hours elapsed since perforation. The average age of the patients on whom a resection was performed was thirty-six and a half years, whereas the gastroenterostomized patients were five and a half years older. This difference in age does favor the prognosis in the resected cases, but nevertheless this and the other records mentioned clearly indicate the speed and the skill with which gastric surgery is done by the German and Austrian trained surgeons. Many more series with such low mortality rates will probably justify the institution by the European surgeons of routine gastric resection in all good risks when perforation has occurred in a chronically diseased stomach or

TABLE II

Collected Series of Partial Gastrectomies and Mortality Rate Percentage for Each. Evident Selection of Good Risks Is Indicated

Author	Number of Cases	Mortality Rate Percentage
Willich	7	59
Hromada	10	40
Iacobovici	16	32
Cukor	12	33
Mulleder	17	29
Riese	44	25
Bagen	84	25
Zoepfel	20	25
Wolff	55	21
Radoievitch	150	18.7
Paugger	89	18.8
Eichelter	41	17
Brütt	55	14.5
Schmidt	19	15.8
Rapant	25	12 —all operated upon within 6 hours
Panek	36	9 —selected
Kott	17	6 —selected
Oderwalt	23	4.4—all operated upon within 8 hours
Schwarz	12	0 —selected
Kuntz	7	0 —selected
Friedmann	10	0 —all operated upon within 12 hours
Burke de la Camp	5	0 —selected
Richard	21	0 —all operated upon within 6 hours
Present Series, 1918–1926	24	16.6
Present Series, 1926–1931	20	5
Total	819—of which 208 appear in Table I	

duodenum. The usual gastric resection performed is a modification of the Billroth II or the Polya operations which remove or "exclude" all ulcers present and are subsequently attended by only a 2 per cent. or 3 per cent. occurrence of marginal ulcers in elective cases. The simpler procedures do not eliminate the danger of leakage or hæmorrhage and have been subsequently attended by a high incidence of unhealed or recurring ulcers that later required resection in the presence of difficulties which raise the mortality rate considerably for so-called elective cases.

SUMMARY.—One hundred forty-four cases of perforated peptic ulcer personally collected in the Schmieden Clinic are analyzed with 4,258 (1897–1931) cases obtained from the German literature. The condition of the patient and not the period of time elapsed from perforation to operation determines the prognosis, which is usually more favorable in patients under forty years of age. The system of practice of medicine in Central Europe is given a large part of the credit for decreasing the mortality rate from 68 per cent. in 1897 to approximately 17 per cent. for the present time. As simple closure of the perforation was reserved for patients who were poor risks, the mortality rate (50 per cent.) percentage accompanying it is higher than it is for gastroenterostomy (13.8 per cent.). Both of these procedures which do not remove the usually present chronically diseased ulcer-bearing portion of the stomach are rapidly giving way to partial gastric resection, which is so successful in the treatment of elective cases of peptic ulcer.

The institution of routine partial gastric resection for perforated peptic ulcer in Central European patients who are good risks is probably justified because: (1) Peptic ulcers are multiple in about 30 per cent. of all patients who have a perforation; (2) gastritis, atrophic, hypertrophic, or ulcerative, is usually present in the ulcer-bearing area of the stomach; (3) the pathology present cannot be evaluated, particularly in the duodenum, by inspection and palpation alone; (4) gastric resection is performed by most German and Austrian trained surgeons in from forty to seventy-five minutes; (5) the mortality rate for patients who are good risks is not over 5 per cent.; (6) gastric resection for perforated ulcer is usually technically easier than it is in elective cases of peptic ulcer; (7) the simpler procedures do not always cure the ulcer or alleviate the gastritis present and are frequently followed by recurrences of peptic ulcer or the development of a marginal ulcer. Gastric resection which is usually required in these failures is frequently extremely difficult to execute and is usually accompanied by a high mortality rate percentage for so-called elective cases.

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ACUTE PERFORATED GASTRIC AND DUODENAL ULCERS

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Two hundred twenty-seven cases of acute perforated gastric and duodenal ulcers have been operated upon at the Detroit Receiving Hospital during a period of thirteen years (January, 1920, to January, 1933). In every case at operation, stomach contents were found freely escaping from the ulcer into the general cavity of the peritoneum. No subacute or chronic perforated ulcers are included in this report. Of these 227 cases operated upon for acute perforated ulcer, 172, or 75.77 per cent., recovered, and fifty-five, or 24.22 per cent., died. The results of the history, examination, operative findings and immediate outcome are herewith tabulated.

Sex Incidence.—It may be noted (Table I) that men were more prone to perforated ulcers than women. Of the four females in this series, three were correctly diagnosed on admission, whereas in the fourth instance a diagnosis of pelvic inflammatory disease was made. One of the perforations among the women was of the gastric variety while the other three were duodenal. All recovered except one of the cases of perforated duodenal ulcer.

Table I

Sex Incidence

Sex	Number	Percentage
Males	223	98.23
Females	4	1.76

Age Incidence at Time of Operation.—It may be seen (Table II) that the majority of perforations occurred in the middle years of life. The average age was thirty-seven years, the five youngest all being nineteen, and the three oldest being respectively sixty, sixty-one and seventy (died) years old. There was a sharp drop in the frequency of perforated ulcers in those over fifty years of age.

Table II

Age Incidence at Time of Operation

Age	Number	Percentage
Under 20 (all 19)	5	2.20
20–30	61	26.87
30–40	82	36.12
40–50	54	23.78
50–60	22	9.69
60–70	3	1.32

Nationality.—As far as nationality (Table III) is concerned, our records seem to show that no race is exempt from ruptured ulcers. Some of those stating they were Americans were naturalized and others were children of foreign-born parents. Of especial interest, however, is the fact that thirty of these patients were Negroes.

TABLE III

Nationality

United States—white	115	Scotch	11
Colored	30	Irish	7
Canadian	19	English	5
South European	12	Jewish	4
Polish	11	Others	13
		Total	227

Occupation.—Statistics regarding occupation (Table IV) were gathered but found to be somewhat misleading. While fifty-six stated they were unemployed, it was known that others belonged in the same category. A glance at the list will readily show that very few had any steady employment and that none were in the private-patient class. This is to be expected in a list of patients reported from a city hospital, rarely admitting others than the less fortunately situated. Among those listed as having unclassified employment there were one farmer, one sailor, one soldier, one fireman and two railway workers.

TABLE IV

Occupation

Unemployed	56	Auto drivers	13
Laborers	47	Clerks	13
Auto industry	28	Machinists	9
Small wage-earners	23	Unclassified	24
Domestics	14		
		Total	227

Seasons of the Year in Reference to Perforations.—Seasonal occurrences of chronic gastric and duodenal ulcer symptoms have long been emphasized. Changes of weather in the spring and fall months have been thought to increase the symptoms. Likewise, many reports of ulcer perforations have shown them to be more common during the same periods. However, our table (Table V) shows that perforations of ulcers increased in frequency during the spring, reached a peak during the summer, gradually decreased in number during the autumn, and reached the lowest rate in the winter months. In this climate dietary indiscretions are more frequent in this class of patients during the summer. Also it may be noted from our table that the death rate was lowest in winter and highest in fall and summer.

TABLE V

Seasons of the Year in Reference to Perforations

Season	Recovered	Died	Total	Percentage Died
Winter	38	7	45	15.4
Spring	48	14	62	22.5
Summer	48	18	66	27.2
Fall	38	16	54	29.6
Totals	172	55	227	

Year of Perforation Comparing Total Number Operations Performed with Number Operated on for Perforated Ulcer.—In the following table (Table VI) we have endeavored to ascertain the frequency of operations performed on acutely perforated ulcers of the stomach and duodenum as compared with the total number of operations done each year in this hospital. The total number of operations have not materially increased, especially during the past ten years. However, there has been a steady increase in the number of operations performed each year for ruptured ulcer. For some time we thought this increase was merely apparent and due to incomplete diagnosis but statistics show the increase to be real.

TABLE VI

Year of Perforation Comparing Total Number Operations Performed with Number Operated On for Perforated Ulcer

Year	Total Number of Operations	Number of Operations for Perforated Ulcer
1920	763	2
1921	3,383	5
1922	3,747	10
1923	3,650	10
1924	3,524	11
1925	3,681	17
1926	3,672	21
1927	3,973	17
1928	4,228	30
1929	4,096	26
1930	4,243	24
1931	4,591	28
1932	4,410	26

Previous History of Gastric Disturbance.—Of note (Table VII) is the fact that nearly 83 per cent. gave a history of previous gastric distress. The majority (156 cases) of these had a history of stomach trouble ranging from one month to thirty years, the average duration being forty-one months. A small percentage complained of dyspepsia all their lives. A third group of twenty-five cases stated that their gastric disturbance had lasted from five to twenty-one days with an average of twelve and four-tenths days. Bloody vomitus was admitted in seventeen and was denied in fifty-three cases. Blood

was recorded in the stools in eleven and forty-seven cases denied having had tarry stools.

Fourteen per cent. denied any type of gastric distress preceding the perforation. Too much dependence was not placed on the denial of previous gastric troubles at the time when the patient had just undergone the agony of perforation. Further questioning during convalescence frequently elicited a very definite history of chronic ulcer. Death shortly after operation prevented investigation into the previous digestive history of others.

TABLE VII

Previous History of Gastric Disturbance

Previous History	Number	Percentage
Positive	188	82.81
Negative	32	14.09
Not recorded	7	3.08
Total	227	

History of Previous Treatment of Ulcer.—Seventeen patients (Table VIII) stated that they had taken no treatment for their ulcers in the past. Twenty-four (10.5 per cent.) reported that they had had more or less regular medical treatment under the direction of a physician. One perforated while on Sippy treatment in this hospital and a number had undergone several courses of medical and dietary treatment. One had had an operation for chronic gastric ulcer seven years before the acute perforation. Two had had perforated ulcers previously closed. Seventy-seven stated they found relief in soda, diet or other self-administered remedies. On their own initiative, six had taken various drugs for relief. A history of previous treatment was not mentioned in the histories of 109 cases.

TABLE VIII

History of Previous Treatment of Ulcer

Treatment	Number	Percentage
None	17	7.4
Medical	24	10.5
Soda, food, or both, etc.	77	33.9
Not mentioned	109	48.0
Total	227	

Pain.—Epigastric pain (Table IX) was the outstanding initial symptom. This was sudden and agonizing in 98.6 per cent. of the cases. In 1.3 per cent. the onset was gradual with pain becoming unbearable in from five to thirty minutes. One complained of a sensation of terrific heat in the epigastrium. Twenty had pain referred to the shoulders.

The records state that after onset the pain remained constant in ninety-eight cases. In eighteen cases it became intermittent. In seven of the

latter, intermittent rigidity of the abdomen was recorded. Most of them were found to have minute perforations in the soft, recent type of ulcer. Food particles plugged the perforations in several. In two patients, the mucosal lining of the opposite wall of the duodenum protruded through the small opening and prevented the continuous escape of gastric contents.

In eight cases, severe straining or direct trauma to the abdomen preceded the pain.

TABLE IX

Pain

Onset	Number	Percentage
Sudden	224	98.6
Gradual	3	1.3

Vomiting with Perforation.—Vomiting, especially vomiting of blood, is one of the rarest findings following perforation of an ulcer. Vomiting (Table X) occurred after the rupture and before the patient was operated on in a little less than half of the cases where this finding was recorded. In most of these it occurred only once or twice or was described as retching. It was recurrent in three cases, blood-stained in two cases, and described as coffee grounds in one case. In one case vomiting occurred before pain and perforation appeared, and another vomited blood fifteen minutes before the pain occurred. It was recorded as provoked in four and followed the administration of morphine in three instances.

TABLE X

Vomiting with Perforation

	Number	Percentage
Positive	96	42.2
Negative	48	21.1
Not recorded	83	36.5
Total	227	

Clinical Findings.—The clinical and laboratory findings (Table XI) coupled with the salient features of the present and past histories served to attain the diagnosis. The average temperature, pulse rate, leucocyte count and white blood count in a majority of the cases showed a slight increase over normal. Collapse or shock was definitely reported as absent in 70 per cent. Intermittent rigidity of the abdomen occurred in 3 per cent. of the cases and aroused suspicion of pneumonia or of lesser abdominal conditions. Obliteration of liver dullness was positive in fifty-four, negative in twenty and not reported in 153 cases. In at least 23.7 per cent. of this series, absence of liver dullness was recorded.

In 131 cases, the blood was examined for the presence of syphilis. Of the twenty cases reported as positive, 75 per cent. died and of the 111 cases reported as negative, 14.8 per cent. died.

TABLE XI

Clinical Findings

Temperature below 99° on admission in 62 per cent.
Pulse below 100 on admission in 73 per cent.
Leucocytes (average 183 cases) 13,385.
Polymorphonuclears (average 183 cases) 81 per cent.
Constant rigidity of the abdomen in 97 per cent.
Intermittent rigidity of the abdomen in 3 per cent.
Liver dullness was obliterated in 23.7 per cent.

Pre-operative Diagnosis on Admission.—This table (Table XII) lists the immediate diagnoses on every one of this series of 227 cases of acute perforated gastric and duodenal ulcers. They were written down in the admitting room immediately on entrance to the hospital. Subsequently, on being put to bed, the diagnosis was corrected or a condition requiring immediate surgery was recognized and all of them were subjected to laparotomy as soon as their condition permitted.

It may be noted that 85 per cent. of the cases were immediately and correctly diagnosed as perforations of gastric or duodenal ulcers. Diagnosis of other acute surgical abdominal emergencies, such as acute appendicitis (in four instances a gridiron appendectomy incision was first made), intestinal obstruction, acute pancreatitis and volvulus, brought the total requiring immediate operation to 96.9 per cent. Acute perforation may be confused with other lesions giving the symptoms of an acute surgical abdomen. Care was taken to rule out the most important non-operative or medical lesions, such as alcoholism, meningitis, pneumonia, tabetic crises, mesenteric thrombosis, and coronary thrombosis. (All of these were among the mistaken diagnoses.)

Röntgenographical and fluoroscopical examination was resorted to in a few of the last cases in the series and was found to be of assistance in the diagnosis, especially when several hours had elapsed after perforation.

It is impossible to compute the exact number of cases in which other acute intra-abdominal conditions were primarily diagnosed as acute perforated ulcers but this mistake was relatively rare. Suffice to say that such a mistaken diagnosis was infrequent with an admitting doctor who had ever seen an acute ruptured ulcer before.

TABLE XII

Pre-operative Diagnosis on Admission

		Number
Cases diagnosed correctly on admission		193
Cases diagnosed incorrectly		34
Considered requiring immediate surgery	27	
Cases wrongly diagnosed—medical	7	

Hours Elapsing Before Operation.—The length of time that had elapsed between the onset of the attack and the operative treatment (Table XIII)

was estimated and varied from eighty minutes to four days. In two instances the interval could not be determined. There was a constant steady increase in the mortality rate with the passing hours.

TABLE XIII

Hours Elapsing Before Operation

Hours	Recovered	Died	Total	Mortality, Per Cent.
Under 6	92	11	103	10.6
7–12	57	11	68	16.1
13–18	11	11	22	50.0
19–24	7	7	14	50.0
Over 24	5	13	18	72.2
Not determined	0	2	2	100.0

Location of Ulcer.—In reference to the location of the perforated ulcer this study (Table XIV) was of interest in regard to frequency and mortality. The majority of perforated ulcers in the series occurred in the duodenum and in this location the percentage of recovery was the best. In some instances the anatomy in the region of the pylorus was so distorted by the pathology presented that it was impossible to differentiate between gastric and duodenal ulcers. These are included in this table with the true pyloric ulcers. Perforated gastric ulcers comprised nearly one-quarter of the cases. That perforations of ulcers of the stomach do occur quite frequently is borne out by the tabulation below. In general, perforation of an old large calloused ulcer was found with a history of long gastric disturbance; a recent, small, soft ulcer was found when the history of previous dyspepsia was short or entirely lacking. In one case multiple fine perforations in a local area were encountered.

TABLE XIV

Location of Ulcer

Location	Recovered	Died	Total	Percentage Died
Duodenum	104	28	132	21.2
Stomach	42	13	55	23.6
Pylorus	26	13	39	33.3
Gastrojejunum	0	1	1	100.0
Totals	172	55	227	

Size of Perforation.—Consistently (Table XV) the larger the perforation the poorer was the prognosis for the mortality was three times greater with the large perforations.

TABLE XV

Size of Perforation

Type	Size	Number	Died
Small	Up to 3 mm.	109	16
Large	.3 to 3 cm.	48	21
Size not recorded		70	18
Totals		227	55

Escaped Gastric Contents.—The mortality was higher (Table XVI) where large amounts of fluid or thick gastric contents had escaped. In the presence of large fluid accumulations there appeared to be an inability or on the other hand, little attempt at closure by adhesions to other structures. Large food particles free in the abdominal cavity increased the gravity of the prognosis. Various terms such as bile-stained, pea-soup, milky, watery, turbid, green and mucoid were used to describe the escaped gastroduodenal contents. Bacteriological examination was resorted to in but seven cases. The smears were all negative. The cultures showed a very few streptococci in one and coli in another instance.

TABLE XVI

Escaped Gastric Contents

Type	Number	Died
Gastric fluid	42	6
Food particles	6	4
Grapes	2	2
Blood stained	3	2
Not stated	10	4
Miscellaneous	164	37

Age Incidence of Deaths.—In reference to age (Table XVII) the mortality percentage remained nearly stationary for all ages between nineteen and sixty years.

TABLE XVII

Age Incidence of Deaths

Age	Number	Percentage
Under 20	1	20.0
20–30	14	23.3
30–40	19	24.6
40–50	13	25.4
50–60	6	23.8
60–70	2	66.6

Time of Occurrence of Death after Operation.—The deaths (Table XVIII) occurring in the first twenty-four hours (36 per cent.) can be ascribed to the overwhelming nature of the attack, to anæsthesia, to operative trauma, or a combination of all three factors. The cause of death of the remaining two-thirds was peritonitis, later complications and secondary operations in otherwise severely handicapped individuals.

TABLE XVIII

Time of Occurrence of Death after Operation

	Number		Number
On Table	3	2–3 weeks	3
24 hours	17	4–8 weeks	3
2–6 days	16	Not stated	3
7–14 days	10		—
			55

Cause of Death.—In determining the cause of death (Table XIX), it was found that general peritonitis was present to a more or less degree in all cases. Death following secondary operations for post-operative complications occurred in six instances. However, from the pathological standpoint, general peritonitis was the outstanding finding in thirty cases. The other causes of death reported, while condensed or limited to one finding, are fairly accurate as post-mortem was obtained in nearly every instance.

TABLE XIX

Cause of Death

Name	Number	Following operation for complications such as:	
General peritonitis	30	Incisional hernia	2
Shock	7	Intestinal obstruction	1
Pneumonia	6	Duodenal fistula	1
Collapse of lung	2	Empyæma	1
Liver abscess	1	Pelvic abscess	1
Pulmonary œdema	1		—
Myocarditis	1	Total	55
Infarct lung	1		

Mortality in Reference to Anæsthetic Used.—The anæsthetic (Table XX) employed was one of many factors considered in reference to the mortality rate. It must be stated that nitrous oxide, local and their combinations were administered to extremely bad-risk patients, which accounts for the poor results with their use. In the good-risk patients, combination anæsthetics including ether or spinal anæsthesia were used. Spinal anæsthesia alone, during the more recent years covered in this series, has become the anæsthetic of choice for operations on perforated gastric and duodenal ulcers. This has been in spite of the fact that one of the three deaths occurring on the table had received spinal anæsthesia.

TABLE XX

Mortality in Reference to Anæsthetic Used

	Anæsthetic		Died	
Type	Number	Percentage	Number	Percentage
Spinal	72	29.6	8	12.5
Gas-ether	62	28.2	17	26.23
Ether	83	37.5	23	28.4
Gas	7	3.2	4	57.0
Local	2	.9	2	100.0
Gas-local	1	.4	1	100.0

Type of Operation Employed.—The type of operation (Table XXI) employed depended upon the condition of the patient, the extent of pathology and the degree of obstruction. Closure alone of the perforation was done in 188 cases (75 per cent.). By closure is meant simple closure, closure with oversewing, closure with neighboring omental grafts or combinations of the three.

Excision of the ulcerated area and closure was done in thirty-six cases, with the lowest mortality rate in the series. In eight of these, the closure was effected by pyloroplasty (Horsley, 4—Judd, 4), with recovery in each instance.

Closure with added gastroenterostomy was employed in twenty-two cases, with a mortality rate slightly less than by simple closure and slightly greater than by excision and closure. As this addition lengthened the operative time, it was rarely used in the more seriously sick. Gastroenterostomy was not employed in any of the ruptured gastric ulcers.

In a series of 132 operations for acute ruptured ulcer since June, 1926, gastroenterostomy was done but once. The operative mortality of this group was 21.3 per cent. as compared with 31.2 per cent. in those done previous to this date when most of the gastroenterostomies were performed.

Closure of the ulcer with extramucosal excision of the anterior half of the pyloric sphincter has not been employed. Laparotomy under local anæsthesia and simple insertion of a drain was not used. None of the larger operations such as pylorectomy or partial gastrectomy has been done for acute perforated ulcer. It seems that more is to be gained by reducing the operation to a minimum than by extending it to a maximum.

Drainage was employed in 203 cases, not used in fifteen and not recorded in nine cases. One of the fifteen cases not drained, died. No macroscopical food débris was seen in those not drained. One to three drains were employed in most instances. Most of these were of the suprapubic variety, some drained Morrison's pouch and a few were brought directly through the incision.

In addition to the operative work for perforated ulcer, the appendix was removed in sixteen cases, the gall-bladder in one and a jejunal catheter was used in one case.

The immediate post-operative care for all was the accepted expectant treatment for peritonitis. On the second or third day, warm water by mouth was started. This was followed by liquid diet and later by a bland type of soft diet.

The average number of days spent in the hospital by the 172 patients who recovered was twenty-one days.

TABLE XXI

Type of Operation Employed

Type of Operation	Number Operated	Number Died	Percentage Died
Simple closure	168	41	24.40
Excision ulcer and closure	36	8	22.22
Closure with gastroenterostomy	22	5	22.72
Gastrojejunostomy repair	1	1	100.0
Totals	227	55	

SUMMARY OF RESULTS

(1) A consecutive series of 227 cases of acute perforated gastric and duodenal ulcers operated on is reported: Less than 2 per cent. were females; the average age was thirty-seven years; many different nationalities were represented; nearly all had no steady employment.

(2) Perforations increased in frequency during the spring, reached a peak number in the summer, gradually decreased in number during the autumn and reached the lowest rate in the winter months.

(3) As compared with the total number of operations done in this hospital during the thirteen-year period covered in this report, operations for perforated gastric and duodenal ulcers have increased in frequency nearly threefold.

(4) A definite history of chronic gastric ulcer was obtained in more than four-fifths of the cases. Ten per cent. had had medical management.

(5) Severe pain in the epigastrium was the outstanding initial symptom. Vomiting, best described as retching, occurred once or twice in about one-half of the cases. Bloody vomitus was conspicuous by its rarity.

(6) In the time permitted for diagnosis, the clinical findings were of far greater comparative value than the laboratory findings. Among the latter, fluoroscopical examination is the exception. On admission to the hospital, 85 per cent. were immediately and correctly diagnosed.

(7) The mortality increased directly with the size of the opening, the amount and extent of the peritoneal soiling and the time allowed to elapse between rupture and operative treatment.

(8) Frequency of perforation, according to location of the ulcer, was respectively duodenal, gastric and pyloric. Recovery was in the same sequence.

(9) The recovery percentage remained nearly stationary for all ages between the second and sixth decades. Thirty-six per cent. died within the first twenty-four hours after operation. General peritonitis was the most frequent cause of death followed by shock, pneumonia and complications requiring secondary operations.

(10) In reference to mortality, morbidity and operation itself, spinal anæsthesia was the most satisfactory anæsthesia employed.

(11) The type of operative treatment employed while individualized was confined to simple closure, excision and closure, and closure with added gastrojejunostomy. Simple closure alone was employed in the last 132 cases in this series. In this group, there was a 10 per cent. reduction in mortality rate. In general, the greater the risk presented at operation, the less was done.

(12) Of these 227 cases operated upon for acute perforated ulcer, fifty-five or 24.22 per cent., died and 172 or 75.77 per cent., recovered.

TOTAL GASTRECTOMY

By Clyde Augustus Roeder, M.D.
of Omaha, Neb.

I desire to report, for the first time, three cases of total gastrectomy performed by me and to offer a bibliography which in my opinion is more or less complete to date.*

According to the literature at my disposal, Pean (Gaz. de Hop. Paris, vol. lii, p. 473, 1879) was the first to have performed a partial gastrectomy upon a human being, but with an operative mortality. T. Billroth (Wien. med. Wchnschr., vol. xxxi, p. 161, 1881), according to the literature, is credited with having performed the first successful partial gastrectomy. The principles of gastric surgery, according to M. R. Reid, originated with Czerny and Kaiser (V. Beitr. z. Oper. Chir., pp. 93-160, 1878) whose work was carried out upon dogs.

The operation of total gastrectomy designates the removal of all of the stomach including a portion of the duodenum and œsophagus. It must be differentiated from the operation which leaves any portion of the upper end of the stomach and which is known as subtotal gastrectomy. Many authors have reported cases of gastrectomy which were in reality subtotal resections, a grave error in recording. The term gastrectomy should, to be correctly used, indicate a total removal of the stomach, and all lesser removals should be known as gastric resections.

The first total gastrectomy upon a human being was quite likely performed by Phineas Connor of Cincinnati in 1884, but his patient was moribund at the time and unfortunately did not live through this heroic effort. No further reports can be found until 1897, when Carl Schlatter recorded a successful total gastrectomy, the patient living about fourteen months. There have been, according to all the reports my assistant, Charles E. Gurney,

* Relative to bibliographies, I feel that we should have an international bureau for bibliographical compilation and conducted expertly and impartially. In the United States the Surgeon-General's library and the Cumulative Index of the American Medical Association have been and still are most useful, but even with their use, authors are confronted with the expenditure of too much time and expense. A bibliography should be complete and fair and begin at the beginning of medical records. It is a wasteful effort of an author's or his assistant's time to endeavor to gather together all of the reports to date, and such translations are too uncertain. It is a worthy task for a bureau of technicians and translators of international function and could easily be supported by the world's medical authors. When an author, as I in this present report, desires to present an article which should be accompanied by a complete bibliography, such a bureau should be at his service. The bibliography, imperfect as it may be, is a far greater effort than the article itself. An international bibliographical bureau should keep all references up to date so that they may be furnished on a moment's notice and at very little cost.

and I could find, a total number of eighty-five total gastrectomies performed, not including the three cases I am reporting in this article which make in all eighty-eight, with an operative mortality of forty-four including the two operative deaths in my series of three cases. I am including as surgical deaths those following the operation as long as sixty days. The most common causes of death were peritonitis and "shock." Probably some of the early deaths from shock were due to hæmorrhage and the later ones reported as due to shock were due to virulent infections. Stomatitis and diarrhœa were troublesome complicating factors and are worthy of mention.

In a report by Finney and Rienhoff (Arch. of Surg., p. 156, January, 1929) most of the recorded cases were tabulated. To those I have been able to add ten cases which those authors did not include.

In a personal communication from Rienhoff of July 27, 1932, he states that he and Finney have done two total operative removals of the stomach. In three other instances so small an amount of the stomach was left that it was completely included with the sutures, resulting in a total destruction or removal, at least functionally, of the gastric segment. Waltman Walters in a letter dated April 19, 1932, reports a total of three cases, the last dying on the fifth post-operative day of bronchopneumonia. P. Peugniez (Bull. Acad. de Med., Paris, vol. xcii, p. 831, 1924) as recorded by Finney and Rienhoff, removed all of the gastric mucosa and left only a small portion of the muscular and peritoneal layer adjoining the œsophagus (Goepel's procedure). This functionally resulted in a total gastrectomy.

The operation of total gastrectomy is increasing in frequency due probably to an increasing number of operators, safer anæsthesia, a wiser choice of the patient to be operated upon and more efficient pre-operative and post-operative treatment. Recurrences following resections of the stomach are in the vast majority of instances found to be in the region of the remaining portion of the stomach in addition to metastases to the liver, retroperitoneal lymph-nodes and more remote regions. This naturally compels one to wonder if a total gastrectomy, in preference to a subtotal, would have prevented a certain number of such recurrences.

In the Proceedings of the Staff Meetings of The Mayo Clinic of December 30, 1931, Adrian Verbrugghen reported a study of the intramural extension of gastric carcinomatous cells. His result showed that at least four centimetres of apparently healthy stomach wall should be removed with the primary growth. Since most of the growths are on or near the lesser curvature of the stomach, one may safely conclude that, excepting those small growths around the pylorus, whenever a portion of the lesser curvature is left a local recurrence is quite likely to occur.

The indications for a total gastrectomy depend upon the judgment and experience of the operator and the local and general condition of the patient. The high mortality rate is the principal contra-indication, while the post-operative life and blood complications are secondary in importance and particularly since primary anæmias are now treated with such satisfactory results. The

patient who recovered in my series of three had an occasional nausea the first week following the operation and has had hunger sensations ever since. The sensations of nausea and hunger, therefore, are not exclusively connected with the stomach. F. G. Mann (Proc. Staff Meetings of Mayo Clinic, vol. xiv, p. 294, 1929) after performing total gastrectomies in dogs, found them with hunger sensations and able to vomit.

The duration of life following total gastrectomies, and those operations in which a very small rim of cardiac end of the stomach is left—practically a total removal, seems to depend largely upon the development of a primary anæmia. Finney and Rienhoff found the longest period to be four years and eight months. In a personal communication by letter dated July 4, 1932, from A. W. Mayo Robson, he stated that a patient is now living over thirty

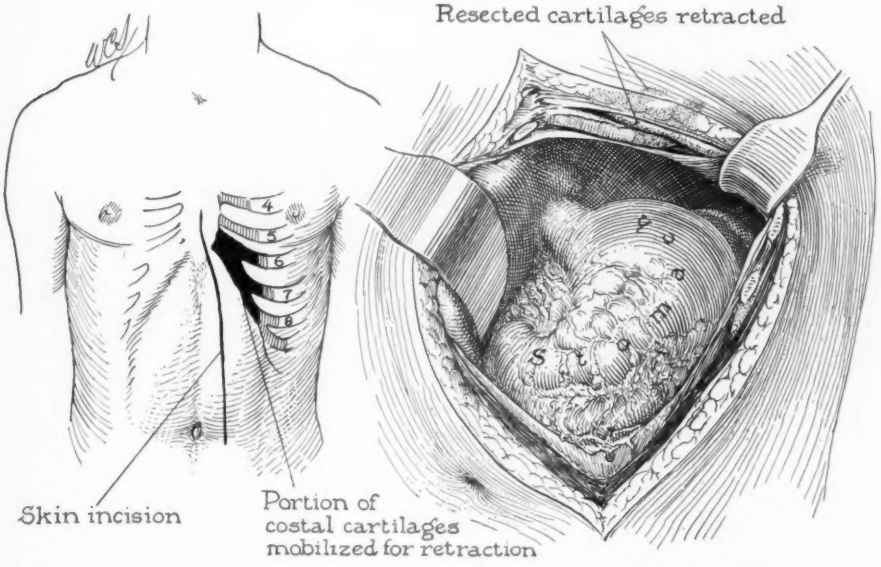

FIG. 1.—Skin incision extends over lower end of the sternum, which allows dissection to the left over adjoining costal cartilages. Shaded area indicates the amount of cartilage cut free from its bed which allows further retraction to the left, exposing the cardiac end of the stomach.

years following an almost complete total gastrectomy. With proper food, hydrochloric acid, stomach extracts and blood-supporting treatment, the length of life may be greatly prolonged. During immediate post-operative treatment, pre-digested food, hydrochloric acid and pepsin may be advantageous.

Technic.—The technic I devised for exposing the cardiac end of the stomach and for producing a larger pouch for the reception of food from the œsophagus was developed without knowing that George Marwedel and Victor Hoffman had preceded me. Marwedel, in 1903, reported a technic by mobilizing a portion of the right costal cartilages for exposing the liver (Zent. fur Chir., vol. xxx, p. 938, 1903) which procedure he later performed upon the left side for exposing the lower end of the œsophagus. In 1922, Victor Hoffman (Zent. fur Chir., vol. xlix, p. 1477, 1922) described

a long entero-anastomosis below the union with the œsophagus with the idea of presenting a greater food pouch. The technic of Marwedel and Hoffman I have used three times, not knowing of their priority, and I feel these

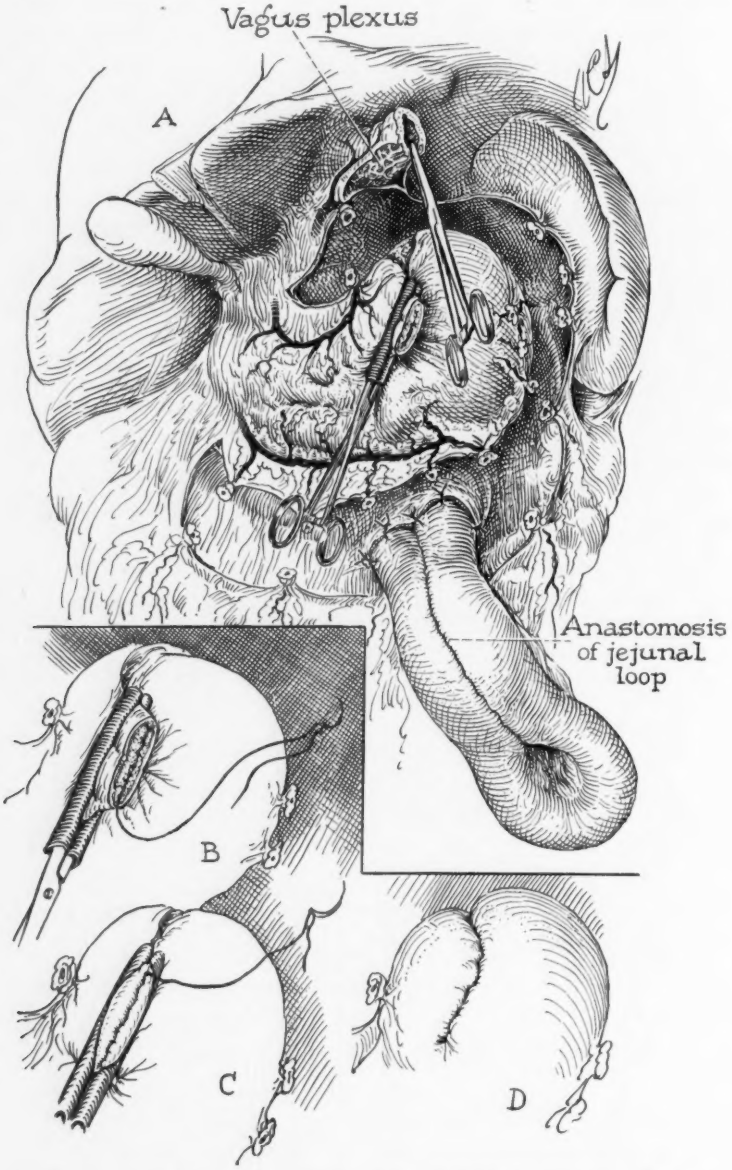

FIG. 2.—"A" shows the œsophagus detached from the stomach. Note the blood-vessel to the lower end of the œsophagus which should be preserved if possible to prevent sloughing. Note the jejunal loop united by a six-inch anastomosis and stitched to the transverse mesocolon to prevent traction and herniation.

procedures are worth considering. In elevating the cartilages there is danger of opening the pleura, an accident which happened with my second case.

The operation (Figs. 1, 2, 3 and 4) is preferably done under spinal

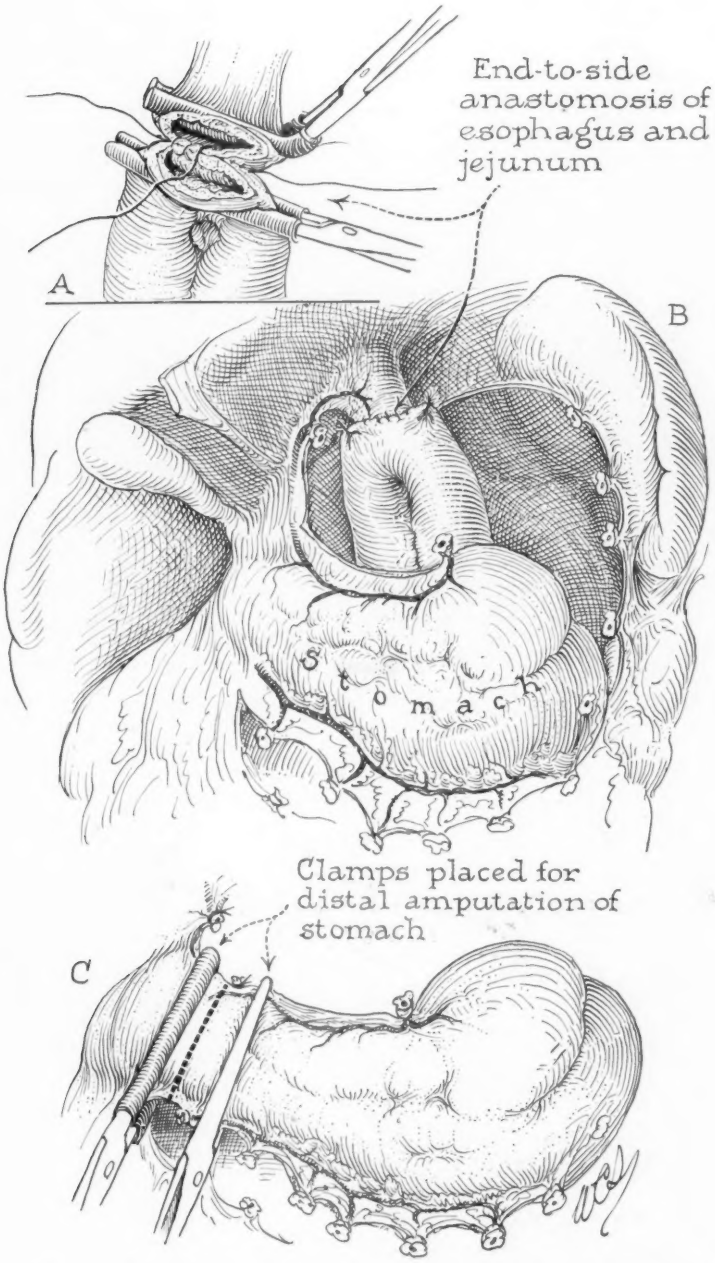

FIG. 3.—Rarely can the duodenum be joined to the œsophagus; therefore, an end-to-side œsophago-jejunal anastomosis is generally indicated. Note the suture on each side of the union which prevents acute angulation. The operation may be stopped here provided a small rubber tube, for the escape of gas, is stitched into the stomach and brought out through the abdominal or stab incision. The adjacent stomach walls should then be sutured to the abdominal peritoneal layer surrounding the tube.

anæsthesia, which gives greater exposure. After the anastomoses are completed, the operation may be stopped and the stomach removed from the duodenum and the blood-vessels during an operation about ten days later. In case this two-stage procedure is decided upon, it may be advisable to insert a tube into the stomach for drainage of gas and fluids out through the closed incision. If the transverse colon and its mesentery appear to weigh heavily upon the jejunal loop, supporting sutures of some kind should be inserted. I feel that my second case would have lived had I taken such a precaution.

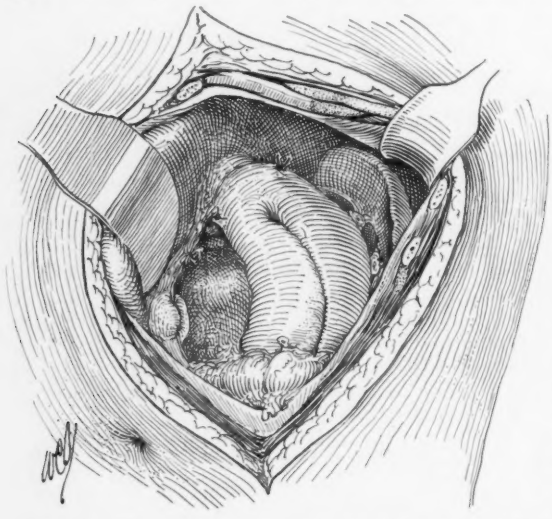

FIG. 4.—The operation completed. Careful notation should be made of the possible traction on the anastomosis by a sagging transverse colon. If this appears probable, the central portion of the colon should be stitched to the anterior abdominal wall.

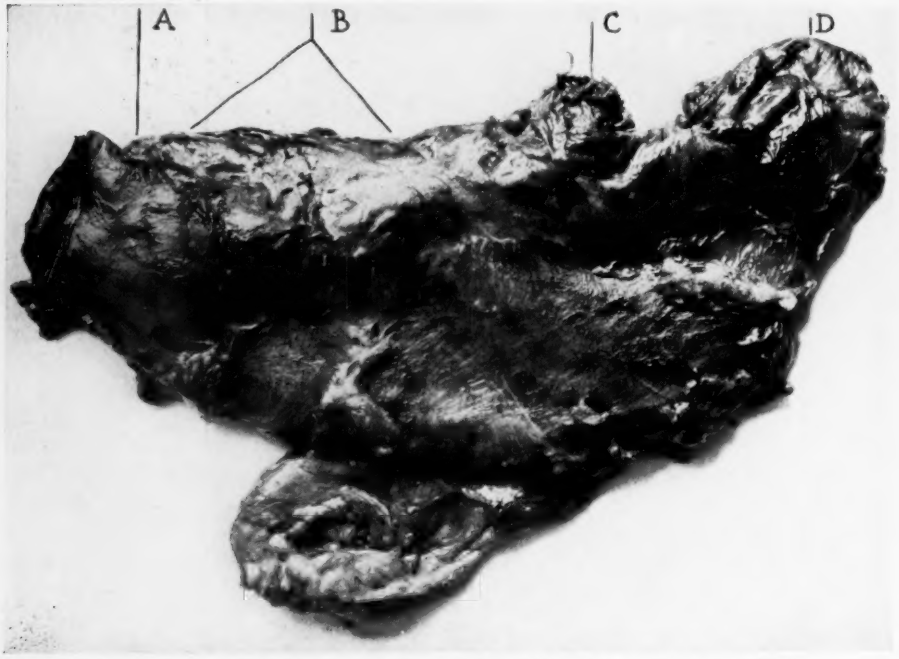

FIG. 5.—(Case II.) The stomach mass after removal. (A) Pylorus. (B to C) Malignant mass. (D) œsophagus.

CASE REPORTS

CASE I (No. 4029).—Male, aged fifty-two operated upon at the Wise Memorial Hospital on October 1, 1922. Gastric symptoms had been present for ten years or more.

An indefinite mass was felt in the epigastrium and X-ray showed a filling defect in the pre-pyloric region. There was no free hydrochloric acid in gastric contents. General examination warranted an exploration, during whch the malignant growth was found involving the pre-pyloric area and apparently extended to within five centimetres of the cardiac orifice. A small mass of malignant lymph-nodes was found within the lesser omentum but no other signs of metastases were noted. A total gastrectomy was performed under ether anæsthesia and a loop of jejunum was sutured to the œsophagus with an entero-anastomosis below. The patient died in sixty-eight hours from a clinical picture resembling pulmonary œdema and on inspection of the operative field there was disclosed nothing of significance. Both pleural cavities were inspected through the diaphragm and each contained about 300 cc. of serous fluid slightly blood-tinged.

The specimen was examined by the attending pathologist, Dr. A. S. Rubnitz, who recorded it as carcinoma with lymph-node metastasis.

Case II (No. 9192).—Female, aged sixty-one, was operated upon at the Immanuel Hospital on February 12, 1931. Gastric symptoms had been present for one year with a definite movable mass in the epigastrium. There was no free hydrochloric acid and a

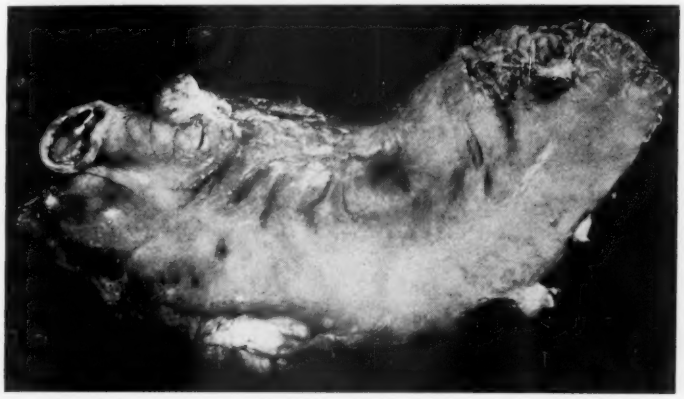

Fig. 6.—(Case III.) The stomach mass after removal. Indentation on anterior wall near lesser curvature is opposite crater in mass involving posterior wall.

secondary anæmia of about 50 per cent. of the normal was present with a loss of weight of about 25 per cent. of normal. The X-ray indicated a malignant pre-pyloric mass apparently not adhered to any marked degree. Under spinal anæsthesia a total gastrectomy was performed and the jejunum was sutured to the œsophagus with an entero-anastomosis below. The patient died five days after the operation and only a local inspection was permitted. (Fig. 5.) The anastomosis was intact but a loop of ileum below the transverse mesocolon and about six inches in length had become gangrenous, probably due to the weight and drag upon its blood supply by the transverse mesocolon and transverse colon. This is a very important point to keep in mind following total gastrectomies. The patient died of peritonitis from perforation of this gangrenous loop.

Case III (No. 38466).—Male, aged fifty, operated upon at the University of Nebraska Hospital on April 9, 1932, where I was assisted by the house surgeon, Willis D. Wright. Gastric symptoms had been present for the past six months, and no definite mass was palpable in the epigastric region. The X-ray examination disclosed a large crater with possible perforation on the posterior wall near the lesser curvature. Free hydrochloric acid was present in the gastric contents, and other laboratory and physical tests were negative except for a loss of weight of 20 per cent. and some loss of strength. Under spinal anæsthesia and carbon dioxide inhalation the stomach was found to contain a hard mass with a crater two centimetres in diameter well up on the posterior wall

near the lesser curvature. No glandular involvements nor metastases were demonstrable. Since the mass felt typically malignant and extended to within a few centimetres of the cardiac orifice, a total gastrectomy was performed. (Fig. 6.) The jejunum was united with the œsophagus, end-to-side, and a large entero-anastomosis, as in Cases I and II, was added below.

The post-operative course (Fig. 7) was uneventful and the blood-picture, with a particular study of the reticulocytes, remained normal during the several months the patient was under observation. About one week after the operation he had sensations of hunger and nausea. A report two months after the operation stated that he felt well and was working at his previous occupation, that of a paint contractor. Dr. J. C. Kildebeck, Emerson, Nebraska, his physician, reported on July 26, 1932, that the patient was feeling very well and was eating only three times a day and the same amounts of all kinds of food such as he consumed before he first became ill. The blood picture of this patient—cellular and chemical—shall be followed regularly and reported if possible at a later date. This patient has definitely proven that the sensations of hunger and nausea occur without a stomach.

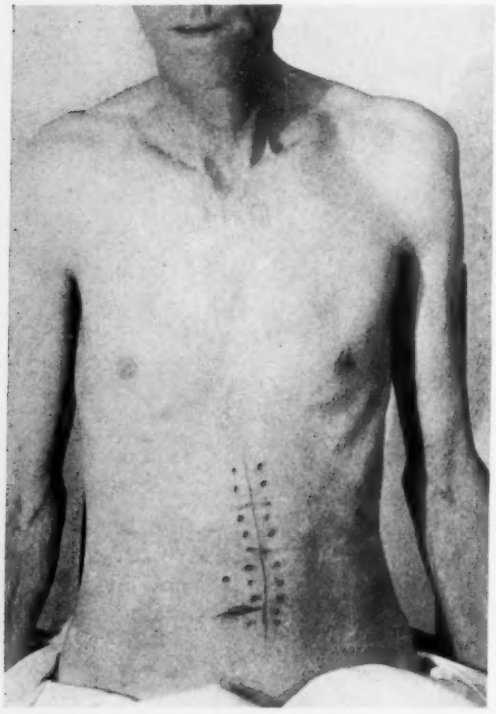

FIG. 7.—(Case III.) Total gastrectomy. Patient four weeks after the operation. Eight weeks after removal of the entire stomach he was eating three normal-size meals a day consisting of all kinds of food not predigested.

Sections of the mass surrounding the crater disclosed no malignant cells and the cake-like feeling mass may have been due to inflammatory changes.

CONCLUSIONS.—Including Walters' third case reported to me by letter and my three cases, there have been recorded eighty-eight total gastrectomies with forty-four operative deaths from shock, hæmorrhage and peritoneal or pulmonary infection. In the future, with improved anæsthesia and surgical technic, shock, hæmorrhage and peritoneal infections should markedly decrease in frequency. The pulmonary complications will probably be the last to diminish. Improved treatment for primary anæmia may prevent the development of primary anæmia which was so frequent following the earlier gastrectomies.

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CARDIOSPASM: ITS DIAGNOSIS AND TREATMENT *

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There is probably no disease that responds more satisfactorily to proper treatment than cardiospasm. Undoubtedly, much of the confusion which exists relative to the diagnosis and treatment of the disease is due to the various terms under which it is described, such as achalasia of the œsophagus, phrenospasm, hiatal œsophagismus, megalo-œsophagus, and idiopathic, fusiform and diffuse dilatation of the œsophagus.

Properly to evaluate the efficacy of any given type of treatment of cardiospasm, it is imperative to know on what criteria the diagnosis has been based, since so many simulating conditions must be excluded to gain an accurate conception of the efficiency of the treatment applied. In this report only cases are included in which there was definite röntgenological evidence of cardiospasm, namely, persistent fusiform narrowing of the lower end of the œsophagus with obstruction and dilatation. At some point in the development of cardiospasm, the röntgenological evidence may be very scanty and indefinite, but such border-line cases have been excluded.

As Plummer has stated: "The symptom complex in cardiospasm is as a rule almost pathognomonic." The course of the disease may be divided into three stages: (1) Cardiospasm without regurgitation of food; (2) cardiospasm with immediate regurgitation of food, and (3) cardiospasm with dilated œsophagus; the retention of food is in the dilated portion and it regurgitates at irregular intervals.

The onset of cardiospasm is usually insidious. Dysphagia is the prominent and the first symptom, and usually is intermittent. It first manifests itself by a sense of lagging and later actual obstruction under the lower end of the sternum. The impediment at first may be noticeable only when the patient is under emotional strain or has swallowed too rapidly. Days or weeks may intervene between attacks. With time, the difficulty increases and becomes more pronounced. Although the point of obstruction is generally situated under the lower end of the sternum, occasionally it may be referred to a point high in the throat. The dysphagia is likely to occur during the first portion of the meal. At first, the obstruction may be overcome by swallowing several times in rapid succession or by taking several swallows of water in rapid succession and washing the food on into the stomach. With increased obstruction, such simple measures may not be sufficient. The patient soon learns to swallow several glasses of water in rapid succession, take a deep breath, close the glottis and compress the thorax, thus

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increasing the intrathoracic pressure above the normal and forcing the food on into the stomach, regurgitating the remainder of the fluid. The symptoms may be intermittent over a considerable period, but they tend to progress until there is difficulty with every meal. Cardiospasm can be readily distinguished from other forms of œsophageal obstruction by the duration of symptoms and the fact that cold liquids usually give as much difficulty as solid food. Ice-cold drinks and such solid boluses of food as raw apples are probably the greatest offenders and most conducive to trouble.

FIG. 1.—Cardiospasm, demonstrating marked angulation and kinking.

Gradually, in the course of the disease, the œsophagus dilates above the point of obstruction, due partially to the effort at propulsion of the food past the point of obstruction, but more likely due to some change in the neuromuscular mechanism, since dilatation, such as occurs in cardiospasm, is not encountered in other types of œsophageal obstruction. When dilatation has occurred the first portion of the meal passes into the stomach, whereas the remainder is regurgitated or remains stagnant in the œsophagus. Of the contents that remain in the œsophagus at the completion of a meal, the more fluid portion

tends slowly to seep through the cardia and on into the stomach. The solid food with much mucus remaining in the sac is then regurgitated at frequent intervals. Solid particles of food such as meat may remain in the œsophagus for days, and food taken subsequently will pass into the stomach, the meat finally being regurgitated after several days.

Plummer was one of the first to note that the œsophagus may lengthen in cases of cardiospasm and by kinking will lead to increased dysphagia and stagnation. (Fig. 1.) Because of the increased obstruction and retention, there is increased necessity to swallow continuously. The diet is limited to soft and liquid food taken in small amounts and washed down by large amounts of water. Considerable time must be spent over a meal. It may be necessary to empty the œsophagus during the course of a meal. This is embarrassing, and patients avoid eating in public. With restriction of diet, there is loss of weight. The obstruction may become so severe that it is impossible to get even fluids into the stomach, and if treatment is not instituted, death will result.

Pain is sometimes a prominent symptom. It varies in intensity from slight discomfort under the lower end of the sternum to severe colic in the same region or radiating to the back or up into the neck. It usually comes on during the course of the meal and when present may last until the œsophagus is empty. Vinson has pointed out that the pain may easily be misinterpreted as gall-bladder colic. Less frequent symptoms are hiccough and dyspnœa. Dyspnœa occasionally occurs as a result of a hugely dilated and filled œsophagus causing interference with respiration.

Should doubt exist as to the diagnosis after röntgenological examination, recourse should be made to the passage of a No. 45 French sound over a previously swallowed silk thread. In cardiospasm, there is an elastic feel at the cardia on passage of the sound with usually slightly more obstruction than normal, but the sound passes readily into the stomach. Œsophagoscopy does not offer as much from a diagnostic point in cardiospasm as in other diseases of the œsophagus, but should always be resorted to when there is any doubt as to diagnosis.

Various measures have been advocated in the treatment of cardiospasm, varying from palliative to operative. Palliative measures such as fluid diet, effervescent drinks, bromides and atropine, may afford temporary help. Relief at times may be secured by passage of stomach tubes and sounds; in some instances gastrostomy is resorted to. The foregoing procedures, however, are not usually effectual and something more drastic must be used. Mechanical dilators have been described and used by Lerche, Brünings, Jackson, and Mosher. Mikulicz, in 1904, first described and reported on treatment of the cardia by gastrostomy with the use of a rubber-covered forceps. Other surgical procedures such as anastomosis between the abdominal œsophagus and stomach and the longitudinal incision through the muscular wall of the abdominal œsophagus have been advocated. Although some of the procedures have afforded satisfactory results, the operation is usually attended

by a high degree of risk, with the added disadvantage of frequent recurrence and failure completely to relieve symptoms.

In The Mayo Clinic, extensive use has been made of the rubber-covered silk balloon. This type of dilator was first advocated by Russel and later modified by Plummer, who used water as the dilating medium. All dilatations are carried out over a previously swallowed silk thread held taut, which eliminates all danger of perforation. Blind bougienage is mentioned to be condemned as an unwarranted and dangerous procedure. The thread is started twenty-four hours before dilatation and at least five yards should be

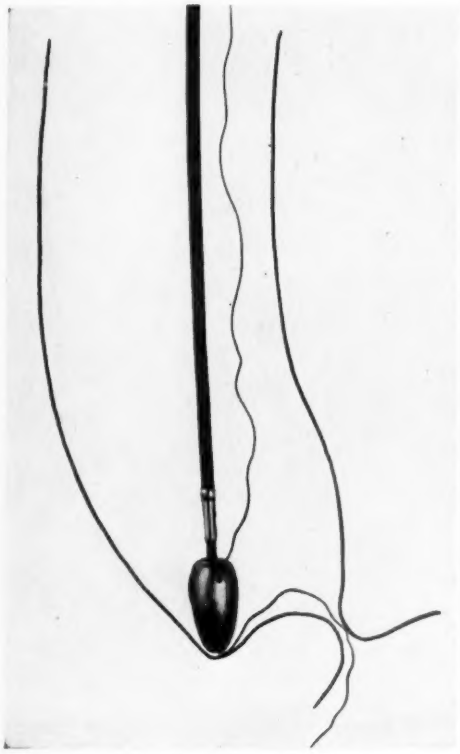

FIG. 2.

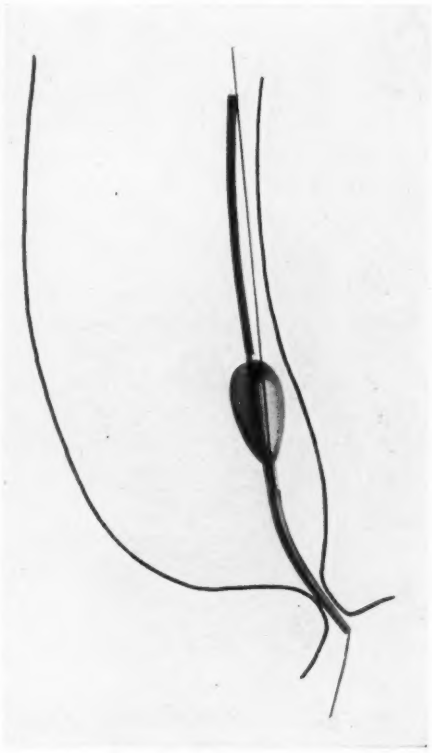

FIG. 3.

FIG. 2.—The value of the thread and the necessity of keeping thread taut, thus preventing possible perforation.

FIG. 3.—The manner in which a No. 60 French sound is passed into stomach with thread as a guide.

ingested. Twisted silk is preferable to braided silk, as it is swallowed with less difficulty. The thread should be taken very slowly, averaging about a foot an hour, and care should be exercised not to chew the thread to avoid snarling. The patient is permitted to partake of food during this period and to sleep at night with the thread in place. Occasionally, several days may be required to get the thread properly anchored. In rare instances in which there is marked œsophageal obstruction, with dilatation and angulation, some difficulty may be encountered. In such cases, two simple procedures are available. Several small shot may be attached to the end of the thread; then

by having the patient change position of the body, thus making use of gravity, the shot pass down to the cardia where they usually readily drop into the stomach. The course of the shot can be checked under fluoroscopical guidance. It is well to lavage the œsophagus thoroughly before starting the thread, as solid particles of food that may interfere with the passage of thread are removed. The use of atropine may also be tried in conjunction with the foregoing procedure, but does not usually afford much aid. If complete obstruction of the œsophagus exists, or if the foregoing procedures fail, the end of the thread with the shot attached can be dropped into the stomach

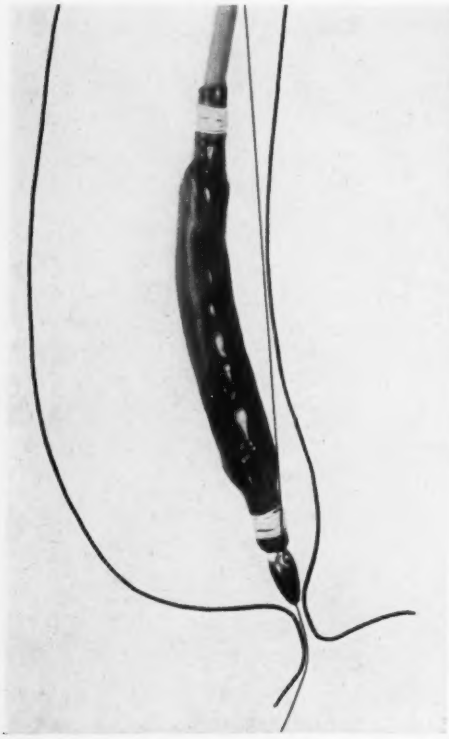

FIG. 4.—Passage of Plummer hydrostatic dilator.

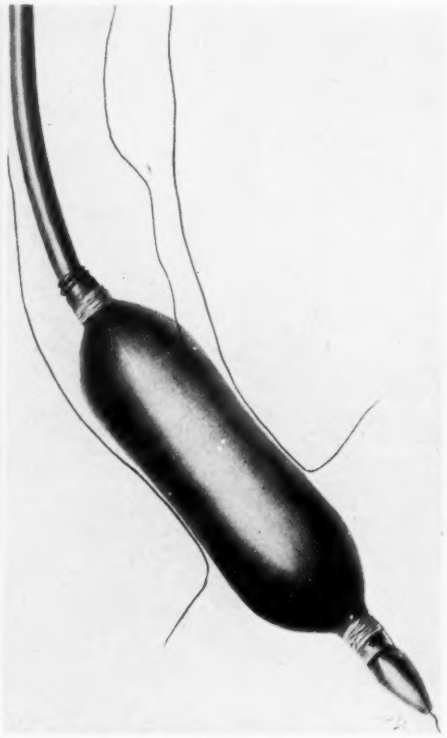

FIG. 5.—Expansion of Plummer hydrostatic dilator while in cardia.

by means of the œsophagoscope. I have never seen a case of cardiospasm in which it was impossible to get a thread in place. With the thread firmly anchored and used as a guide (Fig. 2), a No. 41 French sound is passed to determine the approximate distance of the obstruction from the incisor teeth and at the same time to determine the character of the obstruction. This simple procedure usually affords the patient some benefit, although it is rarely permanent. Formerly, this procedure was followed directly with the hydrostatic dilator, but during the last six years, a No. 60 French sound has been passed first. (Fig. 3.) In many cases, this affords complete relief of all symptoms, but as a rule further dilatation is necessary, and this is done a day or two later by means of the Plummer hydrostatic dilator. (Figs. 4 and 5.)

The change in technic was devised to permit of a more gradual dilatation and thereby permit of better drainage of the œsophagus, promoting epithelization of denuded and ulcerated mucosa which results from stagnation. With improved drainage, the ulcerated areas melt rapidly, with marked improvement in the tonus of the œsophagus. Previous to using the No. 60 French sound, as a preparatory stage to the use of the hydrostatic dilator, death resulted in approximately 1 per cent. of the cases following primary dilatation with the hydrostatic dilator, due to splitting of the œsophagus. Since 1926, the use of the No. 60 French sound has been carried out as a routine at The Mayo Clinic, preceding the hydrostatic dilatation, and since then there has not been a fatality in the treatment of approximately 400 consecutive cases.

Up to January, 1932, 810 cases of definite cardiospasm have been observed at The Mayo Clinic. Many other cases in which treatment for cardiospasm was given have not been included because of lack of clear-cut röntgenological evidence of the presence of cardiospasm. Treatment was given in 805 of the 810 cases. The results obtained by dilatation, either by sounds or by hydrostatic dilator, are as follows:

Eight hundred four dilatations were given; 670 patients were traced; 475 were considered cured, including those with slight intermittent dysphagia; 105 patients were moderately relieved; thirty-two were slightly relieved; thirty-two received no benefit; three refused treatment; nine died from splitting of the œsophagus (no deaths since 1926); two died from starvation before treatment could be instituted, and twelve died at home from other causes; the condition of dysphagia at that time was unknown. In three cases, owing to marked angulation of the œsophagus, it was not possible to place the hydrostatic dilator to secure dilatation and operation was performed. In each case, a Mikulicz operation, or manual dilatation of the cardia, was carried out through a gastrostomy.

In 71 per cent. of the cases in which dilatation was done the condition may be regarded as completely relieved. It is frequently stated by opponents to this type of treatment that the necessity for repeated dilatations is an objectionable feature. The inaccuracy of such a statement is well illustrated in a summary of the number of dilatations necessary in the treatment of 125 consecutive cases of cardiospasm in which the average number of dilatations was less than two. The largest number of dilatations in any case was ten; in the majority of cases only one dilatation was required. It is a rather interesting fact that the results are as good if not better in cases of long standing as in those of short duration. The average duration of symptoms in the cases in the clinic has been about seven years. As I have pointed out, the disease may be present in infancy and childhood, and the treatment in such cases is the same as for adults.

No doubt a certain percentage of many of the patients listed as only moderately improved, or unimproved, could be further relieved by subsequent

dilatation. Further treatment usually has not been tried as the patients feel that they are able to get along fairly well in their present condition.

There are various reasons for failure to obtain satisfactory results from hydrostatic dilatation, the most common of which is failure to use a thread as a guide. This thread is absolutely essential in order to have the dilator directly in the cardia at the time of dilatation. Should the dilator slip too far into the stomach on expansion, it will pull itself into the stomach; if it is not far enough in the cardia, it will push up into the œsophagus on expansion, thereby failing to dilate the cardia thoroughly. When difficulty is encountered in locating the cardia, the dilator can be placed in the stomach, expanded, and then pulled firmly against the cardia. The pressure is released and the dilator is pulled into the cardia and rapidly reëxpanded. Fluoroscopical guidance is also available, but adds to the confusion and difficulty of manipulation. With the dilator properly in place, substernal pain is practically always present on dilatation.

The dilating bag must be of proper size and shape to obtain satisfactory results. The degree of water pressure is also of importance; in the majority of cases a pressure of eighteen to twenty-four feet of water will be sufficient, and this should be varied with the degree of dilatation present and the degree of discomfort produced.

In conclusion, it may be stated that cardiospasm is amenable to treatment by means of the Plummer hydrostatic dilator and when preceded by passage of a No. 60 French sound, should be carried out without risk.

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EXTERNAL DUODENAL FISTULA

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Acute external duodenal fistula is a serious and formidable complication of disease of, or injury to, this portion of the alimentary tract. Colp,[1] who reviewed the literature to 1923, collected sixty-one cases with a mortality of 51 per cent. Since that time several significant contributions have been made concerned chiefly with studies of the cause of the profound bodily disturbances which usually accompany this lesion, as well as adequate measures for combating these changes. Valuable suggestions have also been made regarding the treatment of the wound itself so that Bohrer and Milici[2] were able recently to collect forty-four additional cases (since 1923) with a mortality of 18 per cent.

It is unnecessary to review again the causes, pathological physiology, and symptoms of duodenal fistula, as these have been adequately dealt with in recent contributions. Suffice it to say that the chief contributing factor is surgical attack on the duodenum or some neighboring structure (stomach, gall-bladder, biliary ducts, and right kidney).

The profound constitutional disturbances resulting from this lesion had intrigued all those who had occasion to see these cases. The mere loss of liquids through the fistulous opening was not sufficient to account for the marked and rapid inanition and exhaustion. It remained for Walters[3] and his associates to demonstrate that the physico-chemical changes that occurred consisted of increasing alkalosis, decreasing concentration of chlorides in the blood serum, and progressive rise in the blood urea. These findings were identical with those found in cases of high intestinal obstruction. Walters[4] subsequently showed experimentally that the chemical reactions in the blood were chiefly the result of the loss from the body of the acid and chlorides of the gastric secretion, the loss of the pancreatic fluids, and disturbances in motility in the upper intestinal tract. Elman and McCaughan[5] had previously pointed out the fatal effect of the complete loss of pancreatic juice, and Dragstedt and Ellis[6] have recently demonstrated the lethal effect of the total loss of gastric juice. This experimental work has led to more rational and scientific methods in combating the symptoms described above.

While it is doubtless true that many small fistulæ close under simple conservative management, the larger openings demand prompt and energetic measures to prevent the rapid decline of the patient. Liquids are withheld by mouth and given intravenously, subcutaneously, and per rectum (saline, glucose, water). Numerous operative procedures which have been advocated at various times have been discouraging—direct suture of the duodenum, gastroenterostomy, and gastroenterostomy with pyloric occlusion.

(Berg.) Jejunostomy, however, has received more and more favorable comment, and this procedure alone has frequently sufficed to bring about a successful issue.

The treatment of the wound has taxed the ingenuity of surgeons for many years. The fact that so many different methods have been suggested and employed is sufficient reason to believe that we have not yet reached the ideal treatment. Whatever else is done, suction must be employed to keep the wound free of secretions. This was first used by Jones and Williams,[7] who did not, however, record their experiences. Erdman,[8] Cameron,[9] and others since then have emphasized this important measure. The skin should be protected by some simple ointment. Potter[10] suggested, several years ago, the use of decinormal hydrochloric acid with a sterile beef and olive oil preparation, the rationale being that the acid neutralized the secretions and the beef extract and olive oil allowed the pancreatic juices to act on it before the secretions acted on the abdominal wall. In a subsequent report Potter[11] added nine cases successfully treated by this method. Others have irrigated the wound with sodium bicarbonate solution,[12] citric acid,[13] and sterile water.[7] Insulin[14] has been used on the continent. Einhorn[15] recommended the use of the duodenal tube.

The attempt to close the fistulous opening by passage of a tube directly through the opening into the duodenum has received little attention. Ahrens[16] reported a case of post-operative duodenal fistula successfully treated by passage of a T-tube into the fistulous opening. A second case treated in similar fashion was reported by Marogna,[17] who passed a long rubber tube into the jejunum through the fistula. The author, however, subsequently resorted to extraperitoneal suture of the opening (the lesion had followed nephrectomy). We were able, in our patient, to pass a small catheter through the fistulous opening into the duodenum. Two things were accomplished by this manœuvre—the amount of secretion was greatly diminished, and the patient was easily fed through the tube. The opening promptly closed.

The fact that this simple and logical procedure has received so little attention prompted us to make a brief report of the following case:

CASE.—Mrs. E. S., forty-two years old, who had had dyspeptic symptoms of the gall-bladder type for many years, was admitted to the hospital with a diagnosis of empyæma of the gall-bladder. The abdomen was opened through a short right rectus incision, and a large abscess cavity was immediately encountered, apparently in the region of the gall-bladder. No further exploration was done. The pus was aspirated and the abdomen closed with two cigarette drains. She was discharged in good condition and returned five months later for cholecystectomy. The gall-bladder was removed after much tedious and difficult dissection because of numerous dense adhesions. In the course of the dissection the duodenum was inadvertently injured, but immediately repaired. The abdomen was closed with gauze drainage. On the fifth post-operative day a profuse foul-smelling discharge was noted in the wound. Methylene blue by mouth reappeared quickly in the discharge and confirmed the suspicion of duodenal fistula. Drainage thereafter became more profuse. The wound was kept as dry as possible by suction, the skin was protected by a thick Kaolin paste, and large quantities of liquids were administered. There was no alteration in the chemistry of the blood. The patient, however, was weak and apathetic,

and despite much care the wound appeared raw and excoriated. After several attempts we finally succeeded in passing a small catheter through the fistulous opening into the duodenum. Feedings were begun at once through the tube and the secretions collected by suction were also re-introduced through the catheter. Within a few days the patient became brighter and more alert, drainage began to diminish, and the wound began to lose its angry appearance. Improvement thereafter was fairly rapid. The tube was removed two weeks after its insertion and the patient was discharged on the thirty-ninth post-operative day with the fistula closed and the wound entirely healed. She was re-examined one year later and save for a small incisional hernia was in excellent condition.

Summary.—A case of post-operative (cholecystectomy) duodenal fistula is reported successfully treated by passage in a tube through the fistulous opening into the duodenum. With tube in place the amount of secretion in the wound is diminished and through it a patient may be adequately fed. Where feasible this procedure is suggested because of its simplicity.

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THE EXCORIATIONS AROUND EXTERNAL GASTRO-INTESTINAL FISTULÆ

EXPERIMENTAL STUDIES ON THEIR ETIOLOGY AND FURTHER EXPERIENCE WITH THE KAOLIN POWDER TREATMENT

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While the excoriations of the abdominal wall in the region around a duodenal fistula or an ileostomy opening have long been suspected of being due to tryptic digestion, no conclusive experimental proof of this, has been forthcoming. In the first place, the ability of an enzyme to digest the living skin has not been definitely demonstrated, and in the second place, there is the possibility of the excoriations being due to a bacterial process. The fact, however, that the excoriations are erosive rather than sloughing in character would suggest a non-bacterial and non-inflammatory process. Moreover, there are other instances of enzymes attacking living tissues, such as fat necrosis in some types of pancreatic disease.

Blad[1] has shown that pancreatic juice injected into the gall-bladder which is prevented from emptying by ligation of the common duct causes changes in the gall-bladder wall, which terminates in necrosis. This observation was recently confirmed by Westphal[2] and Wolfer,[3] the former ruling out the bacterial factor by passing the pancreatic juice through a Berkefeld filter before injecting it into the gall-bladder.

Babkin,[4] in Pavlov's laboratory, made a significant observation on dogs with pancreatic fistula. In the operation to establish the fistula, a small piece of the duodenal wall is exsected, having the papilla of the pancreatic duct opening in the middle of its mucous surface. The exsected piece is then brought to the surface and stitched to the abdominal wall. In dogs in which the exsected piece of mucosa is left in place on the abdominal wall, the latter is liable to suffer severe excoriations, while in those in which it is excised, excoriations do not occur. This observation is explained thus: the unactivated trypsin, formerly called trypsinogen, from the pancreas needs activation by the enterokinase from the duodenal mucosa before it can cause excoriations (digestion).

Skin Digestion Experiments.—In our laboratory in five series of experiments on the dog we have been able to show the tryptic nature of excoriations. Briefly they are:

Series I.—(Five experiments.) A closed loop was made of the duodenum into which the accessory pancreatic duct empties. By the injection intravenously of secretin, an abundance of fluid was collected in the loop. This fluid was made to flow into the inguinal fossa of another dog and kept there at a temperature of 38° C. Visible skin excoriations occurred in eight to ten hours.

Series II.—(Three experiments.) The accessory pancreatic duct* was

* In the dog the accessory pancreatic duct is larger than that which corresponds to the main pancreatic duct in man.

cannulated and the pancreatic juice, stimulated to flow by secretin, was led in a similar fashion into the inguinal fossa of another dog. No visible excoriations occurred in fifteen to eighteen hours.

Series III.—(Three experiments.) The pancreatic ducts were ligated, and the duodenal juice was applied to the inguinal fossa of a second dog

FIG. 1.—The inguinal fossa of a dog showing beginning excoriations caused by the application of ultra-filtered duodenal juice.

under identical conditions as the above. No excoriations were present in fifteen to eighteen hours.

Series IV.—(Three experiments.) The pancreatico-duodenal juice was collected from a dog aided by the injection of secretin. This juice was ultra-filtered through a Zsigmondy membrane filter to render it bacteria-free (checked by sterility tests) and applied to the inguinal fossa of a second

dog under the same experimental conditions. Excoriations occurred in five to eight hours. (See Fig. 1.)

Series V.—(Five experiments.) A 1 per cent. aqueous solution of pancreatin (Merk) was raised to pH 7.0 by the addition of a 1 per cent. sodium carbonate solution and applied to the inguinal fossa of a dog. The mixture was kept at a temperature of 38° C. throughout the course of the experiment. Excoriations were visible in ten to twelve hours. By raising the pH to 8.2, they occurred in five to eight hours. Controls of sodium carbonate solutions at pH 7 and pH 8.2, or of the boiled mixture raised to the same hydrion concentration, showed no excoriations at the end of fifteen to eighteen hours.

The first three series of experiments show that the excoriative process depends upon the activation of unactivated trypsin by enterokinase; that is, the process is due to tryptic digestion.

The fourth series shows that the excoriations are not bacterial in origin.

The fifth series shows that the excoriations are reproducible by commercial pancreatic enzymes and that the production of these excoriations is hastened by raising the pH to nearer the optimum for trypsin action.

Colonic Fistulæ.—Strangely enough, excoriations around cecostomy openings, fecal fistulæ or other types of artificial ani have not so generally been recognized as being caused by digestion, probably due to the erroneous belief that trypsin becomes inactive or disappears on passing through the iliocecal valve, and that it ceases to act in an acid medium.

As a matter of fact, trypsin can almost always be demonstrated in the fecal discharge from a cecostomy and often in that from a sigmoidostomy. The table below represents a study made on the tryptic contents of stools collected from eight cecostomy and five sigmoidostomy cases. The Fuld-Gross[5, 6] method of trypsin determination as described by Porter[7] was used. Briefly, the method consists in making fecal solutions (filtrates) of 1/10, 1/100 and 1/1000, the introduction of each dilution in two cubic centimetres, one cubic centimetre and .5 cubic centimetre quantities into test-tubes, the addition of five cubic centimetres of a .1 per cent. alkaline solution of casein to each tube, the addition of a few drops of toluol to each tube to inhibit bacterial activity and the incubation of the tubes at 38° C. for twenty-four hours. At the end of this time, six drops of 1 per cent. acetic acid are added to each tube. In the tubes in which digestion is complete, the liquid remains clear, while in those in which some casein still remains, it is precipitated. A unit is taken to represent that amount of trypsin present in one cubic centimetre of the extract that completely digests one cubic centimetre of the casein solution. Thus if one cubic centimetre of 1/1000 digests five cubic centimetres casein solution, then one cubic centimetre of undiluted extract would digest 5,000 cubic centimetres of the solution, and the unitage is therefore 5,000.

TABLE

Trypsin Contents of Fistular Fecal Discharge

Name	Type of Fistula	Character of Discharge	Units Trypsin
G. B.	Cecostomy	Semi-fluid	1000
W. F.	Cecostomy	Soft solid	500
E. M.	Cecostomy	Fluid	1000
G. C.	Cecostomy	Fluid	2000
F. H.	Cecostomy	Semi-fluid	1000
B. I.	Cecostomy	Semi-fluid	500
.....	Cecostomy	Fluid	2000
G. W.	Cecostomy	Soft solid	250
F. W.	Sigmoidostomy	Soft solid	250
D. C.	Fecal fistula sigmoid	Fluid	2000
M. C.	Fecal fistula sigmoid	Semi-fluid	500
F. J.	Sigmoidostomy	Soft solid	250
P. P.	Sigmoidostomy	Soft solid	200

The above table shows that trypsin can often be found in the fæces in relatively high unitage. The statement that trypsin ceases to act in an acid medium is only relatively true. While the optimum reaction of trypsin is between pH 8 and pH 9, it is not inactive until the acidity approaches pH 5.[8] If trypsin were to lose its activity at a slightly acid reaction, then it would fail to act altogether in the small intestine, where, according to McClendon, Myers, Culligan and Gydesen[9] the pH ranges between 5.6 and 6.6. In fact, the stool increases in alkalinity in the large intestine[10] and Howe and Hawk[11] found the reaction of the fæces to be uniformly alkaline, while Robinson[10] found it to be between pH 7 and 7.5.

There are also experimental and therapeutic evidence to believe that even the excoriations in the buttocks of infants with diarrhœa, the condition that has been called diaper disease, ammoniacal dermatitis, Jacquet's disease, *etc.*, by the pædiatrician, may be due to the same digestive process. The infrequency of excoriations around cecostomy and sigmoidostomy openings thus seems not to be due to the absence of trypsin in the stools, but rather to the more solid state of the stool, so that trypsin does not come into intimate contact with the tissues.

Review of Therapeutic Measures.—The control of the excoriations is frequently a vexatious problem. Atropine and sodium fluoride have been used internally without much success in the hope of drying up the discharge. The first advance was made by Jones and Williams,[12] followed by Erdman[13] and Lahey,[14] all of whom employed mechanical aspiration of the fluid discharge from duodenal fistulæ. While this mechanical removal serves an excellent purpose, yet its usefulness is limited where the bowel contents have solidified to any extent.

In 1926, Smith and Christensen[15] reported a series of three cases of perifistular excoriations cured by the use of Kaolin paste made with glycerine. For some reason or other this report passed unnoticed, so that when Potter,[16]

in 1929, reported the less efficient and much clumsier beef-juice-hydrochloric-acid treatment, it was adopted widely by surgeons.

Early in 1926, before the appearance of the work of Smith and Christensen, while searching for a means of controlling the extensive excoriations surrounding a sigmoidostomy opening, we were led to the work of Petersen,[17] in 1917, who demonstrated the inhibiting effect of Kaolin powder on the digestive power of jejunal juice. The use of the powder in our cases was followed by such prompt healing that it was instituted as a routine procedure in treating all types of gastro-intestinal fistulæ. A series of thirty-one cases was collected over a period of three years and published by us in 1930.[18]

Since then we have had 162 cases collected from the surgical and gynecological wards of the New York University Division of Bellevue Hospital, New York, from the Michael Reese Hospital, Chicago, and the Harlem Hospital, New York.* Rankin and Graham,[19] who started using this treatment at The Mayo Clinic in the summer of 1931, reported highly satisfactory results in three cases of high intestinal fistulæ and eleven cases of permanent ileostomies. Sir Arthur Burgess[20] also speaks of the treatment as having revolutionized the post-operative treatment of fistula cases in his practice. In our hands, the treatment has been so successful as to instill in us the confidence that one has in specifics; and we are almost justified in making the statement that with the proper use of Kaolin powder in the routine toilet of an external gastro-intestinal fistula, no excoriations need occur.

Principle and Method of the Kaolin Powder Treatment.—The principle of the treatment is the removal of the enzyme, trypsin, by kaolin particles because of a difference in their electrical charge. This treatment is carried out in the following fashion. A plentiful amount of kaolin powder is applied over the osteum of the fistula and all around it. The number of changes necessary depends upon the condition of the abdominal wall and the amount of drainage. A safe rule is to change the powder as soon as it becomes saturated. In duodenal fistulæ, it is generally necessary to change the powder every hour or every two to three hours; in ileostomies, every four to six hours; in cecostomies, every four to eight hours; and in sigmoidostomies twice a day. It must be borne in mind that the success of the treatment depends upon the removal of as much of the enzyme as the fistula discharges. The application of vaseline to the abdominal wall before using the powder defeats the purpose for which Kaolin is used, as the vaseline-coated particles of Kaolin then become electrically inert.

Advantages of the Kaolin Powder Treatment.—At the time of the publication of Smith and Christensen's work,[15] we had collected seven cases, all treated satisfactorily with the Kaolin powder. It seemed desirable, however, to give Smith and Christensen's method and ours a test of comparative

* We are grateful to Drs. Francis Sovak and Henry Falk for the use of the clinical material from the gynecological ward of the Bellevue Hospital and from the Harlem Hospital, respectively.

efficacy. After a few trials, it was apparent that the powder method was the more effective. This is to be expected. Efficient removal of the enzyme by Kaolin depends upon its intimate mixture with the fistular discharge. In the case of the powder, an intimate contact is insured by capillarity due to porosity of the powder; whereas in the paste, the pores being already filled with glycerine, contact must depend upon the diffusion of the discharge into the glycerine matrix—a much slower process.

The Kaolin treatment has a number of minor and major advantages over the beef-juice-hydrochloric-acid treatment; the minor advantages are that it is less clumsy, comes ready for use, is inexpensive, and that it adsorbs bacteria. The major advantages are:

(1) Because of its simplicity, it can be used for any type of bowel fistula, including ambulatory cases.

(2) There is neither the inconvenience, the discomfort to the patient nor the foul odor that attend the hydrochloric-acid-beef-juice treatment.

(3) It can be used for a prolonged period of time without producing irritation of the skin (in one case as long as six months).

(4) It is valuable in preventing digestion around any fistular opening.

SUMMARY

(1) In five series of experiments on the dog, it was established that trypsin can cause skin excoriations.

(2) One hundred and sixty-two cases of perifistular excoriations treated with the Kaolin powder method are reported. The results were so uniformly good as to justify classifying the treatment as a specific.

(3) The principles, the technic, and the advantages of the Kaolin powder treatment over other existing methods are set forth.

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(1) Professor George David Stewart and Dr. Arthur M. Wright for instituting this treatment at the New York University Surgical Division of the Bellevue Hospital.

(2) Mrs. Ruth Kidd of the Department of Bacteriology for carrying out the sterility tests on our ultra-filtered material.

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ARTERIAL EMBOLECTOMY

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This paper includes a report of arterial embolectomies performed by the writer and a review of the literature from the time that the subject was first brought prominently to the attention of the medical profession by the Scandinavian surgeons, particularly by Einar Key,[35] ten years ago.

The total number of cases collected from the literature of the Scandinavian, German and other European countries, and that of Australian, Canadian and American medical publications, from 1922 to June, 1932, totals 129. These 129 cases were reported by eighty different surgeons. In collecting our material for this paper, we were very careful not to include any of the cases reported by Key in his first paper of 1922. These 129 cases were operated on by a diversified group of surgeons, whose experience with this particular branch of surgery was rather limited. Most surgeons only reported one individual case, some two or three, the highest number reported by any single surgeon in this group being limited to seven cases.

In Key's first collected group of cases published in 1922, beginning with the first successful case of embolectomy performed in 1911, are included reports of operations performed almost exclusively by Scandinavian surgeons. The only case by an American surgeon included in his bibliography is that of Francis Stewart, who removed an embolus at the bifurcation of the aorta several days after its onset with fatal results. Previous to 1911, several attempts to relieve embolic arterial obstruction were made by many surgeons without any success. In Europe, Ssabanejew (1895), Lejar (1902), Moynihan (1903), Handley and Doberauer (1907) performed arteriotomies on various arteries without any success. Trendelenburg (1907) removed an embolus from the pulmonary artery of a woman, sixty-two years old. Death from hæmorrhage took place on the operating table. Since that time, after much experimental work, this operation was perfected by him with some successful results. Proust and Lecéne (1908), Schiassi (1909), Carrel and Lériche in the same year attempted to remove emboli from the femoral, brachial and iliac arteries; gangrene requiring amputation developed in every case. Lériche and Murad (1911) removed a clot from the external iliac artery several days after the onset of the disease. The patient died on the operating table.

In America we find that attempts to relieve this condition by surgery were made by Francis Stewart in 1905 and 1907. Each time he removed an embolus from the femoral artery, and gangrene developed in each case. In 1909, Murphy removed an embolus from the iliac artery, twenty-four hours after onset. Gangrene was already present at the time of operation and the patient died four days later.

Since Labey published his first successful case in 1911, the number of operations performed upon the vessels of the extremities progressively increased, particularly in the Scandinavian countries. From that time on, we find that three arteriotomies were performed in 1912, one of which was for an embolus lodged at the aortic bifurcation, followed by recovery. The same number of operations were performed in 1913 with one good result. In 1914, five operations were performed by five different surgeons, with one successful result. Eight operations were performed during the years of 1915 and 1918, with two successful results. In 1919, Key reported before the Nordischen Chirurgischen Gesellschaft nine embolectomies performed on eight patients, and Wideröe in the same year reported five cases. From that year, up to 1922, there were isolated instances of this operation performed mostly by Scandinavian surgeons, the results of which were published in Key's paper in 1922.[32]

Of the total number of 129 cases included in our review of the literature, covering a period of ten years (1922–1932), 119 were subjected to operation and the diagnosis was confirmed at operation. (Four of these were performed by the writer.) In the remaining ten non-operated cases, the diagnosis was established by the classical clinical symptoms present at the time of onset of the disease, by post-mortem findings, or both. Operation in these cases was not performed for various reasons. We included these non-operated cases in our series for the purpose of comparative study of the end-results of those cases which were operated on, as compared with those in which no operation was done.

The constant progressive increase in the number of operations performed for the relief of this condition may be judged from the number of cases included in this group: twenty-three American surgeons reporting fifty operations during this period, and twenty-one Scandinavian surgeons reporting thirty-eight cases. The remaining number of cases are divided between the British, German, French and South American countries.

We presume that there may be an equal or even greater number of cases which were operated on and not reported in the literature since we are more prone to report our successes than our failures. Some of the successful cases reported in the literature may have escaped our notice, particularly those published in the foreign medical magazines. (E. Andrews, M.D., and Henry Harkins,[3] M.D., state that 216 cases of embolectomies were collected until 1927, of which 145 were done in the Scandinavian countries.) Our group of 129 cases constitute a series sufficiently large to draw some fairly definite conclusions, particularly so since the operative results are not confined to a limited group of surgeons or to any particular country.

Etiology.—The predominating factors in the causation of arterial emboli are affections of the heart and blood-vessels, either in the acute, subacute or chronic stage. It may occur in any of the stages of this disease, but it is apt to occur more frequently in acute exacerbation of a chronic endocarditis, particularly when associated with diseases of the blood-vessels. (Sixty per

cent. of our cases are purely of cardiac origin.) It seldom occurs as a post-operative complication in patients in whom there is no history of a previously existing constitutional disease. In 82, or about 70 per cent. of our operated cases, the etiology was of a cardiac nature. Twenty-two out of these eighty-two patients also suffered from other complicating diseases, such as arterio-sclerosis, diabetes, syphilis, thyrotoxicosis, *etc.* (Table I.) In eighteen cases the embolus followed a surgical operation. In six of these there was a history of cardiac disease existing prior to operation and in the remaining twelve we find that three were operated on for toxic goitre, which is usually associated with cardiovascular changes. The remaining nine cases, whose average age was forty-nine years, might have had some latent heart lesions, not detected at time of operation. From these clinical findings, we may definitely establish the following corollary: that "arterial emboli are almost invariably the result of diseases of the heart and blood-vessels."

TABLE I

Etiology

Alcoholic (?)	2
Arteriosclerosis	6
Arteriosclerosis and diabetes	1
Bullet wound in lung	1
Cardiac	60
Cardiac and post-operative	6
Cardiac and pregnancy	1
Cardiac and syphilis	1
Cardiovascular	9
Compound fracture	1
Diabetes	1
Diabetes and cardiovascular	2
Eclampsia gravidarum	1
Etiology not given	10
Graves' disease and typhoid	1
Malaria (?)	1
Pneumonia (?)	1
Pneumonia and serum sickness	1
Post-operative	12
Puerperal sepsis	1
Septic endocarditis	3
Streptococcus infection	1
Syphilis and aneurism of aorta	1
Syphilis and arteriosclerosis	1
Thrombosis of right iliac vein	1
Thyrotoxicosis	1
Tuberculosis	1
Tuberculosis and pneumonia	1
Total	129

Emboli may originate from a central spot in the artery, usually from the aorta, as was demonstrated in one of our cases by the post-mortem findings. They usually come from the left side of the heart, mitral disease being the

most common cause of cardiac thrombus formation.[32] About 50 per cent. of Key's first collected cases suffered from this form of cardiac affection. Occasionally they may originate in the right side of the heart or in the systemic veins. In the last two possibilities we must presume the presence of a patent foramen ovale, permitting the embolus to pass directly from the right to the left side of the heart, and thence to the general arterial circulation. These are usually spoken of as "paradoxical" or "cross" embolus.

Arterial or venous thrombi, which are occasionally the cause of embolism, are usually the result—according to experimental studies carried on by Aschoff[17]—of changes in the composition of the blood or retarded blood circulation, such as is found in advanced cases of cardiac decompensation, or the result of injuries to the vascular coats, facilitating local thrombus formation.

The importance of early operation is stressed by most writers who, either through a personal experience with several cases, or by a résumé of a collected series of embolectomies, were able to compare the end-results of the cases diagnosed and operated on early, with those cases in which the operation was delayed. It was definitely shown[43] that the longer the period of occlusion, the more extensive is the infiltration of the intima of the blood-vessel causing grave alteration in the vascular lining. The embolus adheres very closely to the vessel wall, causing ulceration and ultimate necrosis at the intima and media, at the obstructed point. This process gradually extends to the vessel walls below the point of embolic lodgment. Very little may be expected from a late operation, since the vascular changes are so far advanced that thrombus re-formation usually takes place after the embolus is removed, causing complete obliteration of the entire arterial canal.

The danger of circulatory obstruction by an embolus is greater than that caused by ligature, because, in the former, thrombi rapidly form and occlude not only the parent vessel but also the arterial branches given off at the embolic site; whereas in obstruction due to ligature, the branches given off below the point of ligation are not obliterated and the circulation may be maintained through these collateral anastomotic branches. Then again we must bear in mind that emboli usually form in debilitated subjects in whom the collateral circulation is definitely impaired.

That ligation of arteries carries with it less risk of gangrene than when the obstruction is due to an embolus, and that there is an appreciably smaller percentage of gangrene following ligation of the arteries of the upper extremities than that of the lower, was definitely shown by Wolf. (Quoted by Key.[32]) Experimental ligation of the common iliac, femoral and popliteal gave a percentage of gangrene, varying from 50 per cent. in the common iliac down to 15 per cent. in the popliteal. In ligation of the subclavian, axillary and brachial arteries, the percentage of gangrene varied from 15 per cent. in the axillary to 4.8 per cent. in the brachial. As will be shown later, the same variation in the incidence of gangrene between the vessels of the upper and lower extremities, as a result of embolic obstruction, also holds true.

While there may be other factors influencing the operative outcome, such as the condition of the patient, the condition of his heart and blood-vessels, the location of the embolus with reference to the accessibility of the vessel and the existence of other concomitant affections, nevertheless the best chances for an operative cure depend upon the promptness of operative intervention. The family physician is usually the one who sees the patient soon after the occurrence of this surgical complication, and unless he is familiar with the modern surgical literature on the subject, or has had some previous personal experience with it, the condition may go unrecognized for several hours or even days, and when the real cause of the trouble is recognized, gangrene has already set in, or the resulting thrombus in the vessel wall has become so firmly adherent, causing such marked changes in the intima of the blood-vessel, that operation is almost futile. At best the ultimate end-results of the cases followed up after their recoveries, even in those instances where the operation was performed within the first twelve or twenty-four hours after the onset of the disease, are far from what would be desired, and unless the general practitioner or even the general surgeon learns to diagnose and promptly render the necessary surgical relief, the operative results will remain far from satisfactory.

Symptoms and Diagnosis.—It is important to differentiate between an arterial embolus and an arterial thrombus which is due to disease of the blood-vessel wall. The history of an organic heart lesion, with recent exacerbation, the presence of some form of systemic infection, a post-operative condition associated with cardiovascular disease, and a sudden onset of pain along the course of one of the vessels of the extremities, should lead one to suspect the presence of an arterial embolus.

In arterial thrombus there is usually a history of prodromal symptoms extending over a period of months or years, such as coldness and numbness of the extremities, intermittent claudication, and all other symptoms of circulatory disturbance that are usually present for a long time before definite symptoms of complete arterial obstruction appear.

The subjective signs of arterial obstruction by an embolus are: sudden onset of pain in the affected limb, which is rather sharp and persistent. This is followed by a sense of coldness, numbness and tingling sensation, with a progressive loss of motion being completely abolished in some cases where the obstruction is complete.

The objective signs are a rapidly changing color of the skin in the affected limb. The skin becomes pale, assuming a marble-like appearance, the temperature of the limb is lowered, motion is markedly restricted and, at times, completely abolished. As the intensity of the obstruction becomes more marked, cyanosis of the skin develops, the discoloration becomes very marked, livid dark blue patches appear, followed by complete gangrene of parts below the obstructed point.

One of the most outstanding and dependable symptoms for early diagnosis is the absence of pulsation in the affected vessel below the point where

the embolus is lodged. This can be easily established—particularly in thin individuals—in those vessels that are somewhat superficial along certain parts of their course such as the axillary or brachial, the first portion of the femoral or popliteal.

In one of my own cases I was able to locate the embolus definitely in the brachial artery, at about the upper third of the forearm before the incision was made. Palpation along the course of that vessel demonstrated a small segment of the artery of a cord-like consistency. There was distinct pulsation above that point and none below it. A tiny little mass, the size of a pea, could be felt within the vessel just above the cord-like segment and could be easily displaced upward into the vessel lumen by gentle massage. We encountered a similar condition in an embolus of the axillary artery.

The location of the embolus is not so easy in those vessels or parts of certain vessels which are covered by muscle and adipose tissue such as the mid-portion of the femoral below Hunter's canal, the posterior tibial, internal iliac and subclavian. It should be borne in mind that when a rich collateral circulation is present the circulatory disturbance may be manifested at a point quite distant peripherally from the point of embolic obstruction.

The most important differential diagnostic point between venous thrombosis and arterial embolism is the fact that in the former the pulse is palpable along the entire course of the limb and the extremity is cyanotic and warm; whereas in arterial obstruction by embolus there is no pulsation below the obstructing point, the color of the skin is at first pale, marble-like in appearance, and the limb is cold.

Pain.—The cause of the sudden onset of pain is usually given as due to the marked ischæmia immediately following the arterial occlusion. Some writers maintain that the pain appears only after the formation of a thrombus of sufficient size to cause complete obliteration of the arterial channel, and that it is not due nor does it follow immediately after the lodgment of the embolus. If that were so, we should get a history of a slowly progressing pain instead of a sudden onset.

The pain, in my experience, is always sudden, without any premonitory symptoms and continues with the same severity as long as the embolus remains lodged in the vessel. Considerable relief from pain is obtained as soon as the embolus is extracted, even in those cases where the circulatory restoration is not complete. It is my belief that the onset of pain is due to the sudden arrest of the embolus along its course in the arterial blood-stream, at or near a bifurcation point, or at a constricted portion of the vessel. This is followed by a spastic contraction of the vessel and the branches given off at or near that point as a result of the vessel's effort to propel the embolus along the arterial course.

Anæsthesia.—Arteriotomies for arterial emboli should be performed under local anæsthesia whenever the vessel involved is easily accessible and extensive dissection is not necessary. The third portion of the axillary artery, the

brachial or superficial portion of common femoral, are particularly adapted for this form of anæsthesia.

In the deep-seated vessels of the lower extremity and the intra-abdominal arteries, spinal anæsthesia should be administered. It is particularly indicated in this condition since most of the patients afflicted with this surgical disease are suffering from an acute exacerbation of a chronic cardiac or cardiovascular disease and are therefore unable to withstand the rather prolonged surgical ordeal necessarily required for the relief of an obstruction in a deep-seated vessel such as the common or external iliacs. (Table II.)

TABLE II

Anæsthesia	Number of Cases
General (ether, nitrous oxide, ethylene, sodium amytal and chloroform)	19
Local	67
Spinal	14
Local supplemented by general	1
Spinal supplemented by general	1
Anæsthesia not stated	17
No operation	10
Total	129

Analysis of deaths with reference to type of anæsthesia shows that it had very little effect on the ultimate operative results.

In analyzing the deaths in our collected group of cases with reference to the type of anæsthesia used we find that it had no particular bearing on the results of the operation. Twenty cases were operated on under general anæsthesia, such as ether, nitrous oxide, chloroform, ethylene, *etc.* Thirteen of these cases died. In five death occurred a week after the operation, seven died many hours after, and only one died within one hour after the operation had started.

Almost all cases that were operated on under general anæsthesia were those in which the access to the vessel was difficult, making the operative risk greater. In five the embolus was in the aorta and six in the deep femoral. The operative results would have probably been the same if local or spinal anæsthesia would have been used. There is no evidence in the clinical record to show that the form of anæsthesia had any direct bearing upon the ultimate operative results, and we are therefore justified in assuming that the general anæsthesia was not of the contributory causes to the fatal outcome in those cases.

Technic of Operation.—Arterial embolectomy is a comparatively simple operation, particularly in the vessels of the extremities. The exposure of the artery is quite a simple process and the localization of the obstructing clot is usually not difficult, since the absence of pulsation below the obstructing point and its presence above that is a most reliable guide. In most instances, the obstructing clot can be easily palpated even before secondary thrombus formation has taken place.

The most common site for the location of an embolus is at or near an arterial bifurcation, or at a point of a sudden narrowing of the arterial canal where the embolus becomes arrested in its flow through the blood-stream. After the site of the obstruction is located the vessel is carefully separated from its contiguous structures and lifted out from its bed by the usual surgical procedure. From this point on every step of the operation should be scrupulously carried out in accordance with the Carrel method of vessel surgery. One rubberized clamp should be applied above the point of obstruction. It is not advisable to apply a clamp below the obstruction, on account of the risk of grasping the thrombus which formed below, thus crushing it and forcing the clots down to the lowermost part of the vessel. The arteries which come off at the bifurcation point should also be clamped to prevent retrograde hæmorrhage.

My own procedure consists of constricting the vessel by ordinary flat sterilized tape, saturated in a 2 per cent. sodium citrate solution. One half-twist of the tape, combined with gentle upward traction on the vessel by an assistant, is usually effective in causing sufficient circulatory constriction, permitting the incision in the artery to be made without any loss of blood. Another advantage of this method over that of the clamps is the ease with which the circulation of the vessel can be controlled after the incision in the artery is made and the clot evacuated. Merely twisting and untwisting the tape and slight upward traction is sufficient to obstruct or release the flow of blood in the artery. There is also less likelihood of additional injury to an already damaged blood-vessel wall that may be brought about by tightly constricting metal forceps applied below the embolus. The application of vaselined gauze to the operative field, as recommended by some, is not practical since it makes the operative area very slippery and seriously interferes with the manipulation of the surgeon. Instead of the vaseline gauze flats saturated in a 2 per cent. sodium citrate solution should be used. All instruments and the surgeon's gloved hands should also be frequently rinsed in the solution so as to prevent blood-clotting.

The incision in the vessel should be made longitudinally, a little above the obstructing point. When the embolus is lodged near the bifurcation of an artery, great caution should be exercised in placing the incision away from that point. Extreme narrowing of the vessel lumen may take place in an already constricted arterial channel, and marked interference in the collateral circulation may result after the incisions are closed if these two points are disregarded.

The segment of artery to be incised should be supported by the index finger of the left hand. Incise the anterior vessel wall with a fine scalpel, exercising great care not to injure the intima of the posterior or lateral vessel walls by the point of the scalpel. The clot is usually evacuated spontaneously, or it may be necessary to dislodge it by digital pressure upward against the vessel wall. A very fine thumb forceps without teeth, dipped in sodium citrate solution, may be introduced into the vessel lumen and the clot extracted.

After the clot is evacuated the constriction of the vessel above the incision may be released and the blood allowed to flow freely. If the obstruction is completely relieved the blood usually spurts freely and occasionally some small fragments of the clot that may have remained in the vessel above the incision are forced out by the stream of blood; but if there is no free flow of blood the assumption is that there is another clot in the artery above the incision or in its parent trunk obstructing the circulation. An attempt should then be made to dislodge it either by another incision into the vessel higher up or by aspiration through a soft catheter introduced into the artery.

Very frequently a thrombus forms below the point of occlusion, extending for a considerable distance into the lumen of the distal portion of the artery and occasionally also blocking the arterial channel of a branching vessel at that point, seriously hindering the establishment of collateral circulation. It is therefore important to determine, before the primary incision is closed, the presence of such thrombi and dislodge them either by very light upward digital massage, by aspiration or, if necessary, through a secondary incision made distal to the primary one. Before making this incision, the vessel should be constricted below that point so as to avoid the dislodgment of clots to the periphery of the vessel or its branches.

After having determined the condition of the arterial canal above and below the obstructing point, and being reasonably certain that no further obstruction is present, particularly at the proximal portion of the artery, as indicated by the free spurting of blood synchronous with the pulse beat, the upper portion of the artery should again be constricted and the incision closed. The needles should be of the finest size, threaded with fine silk, dipped in sterile vaseline, albolene or 2 per cent. sodium citrate solution. The suture should be inserted close to the edges of the incision so as to avoid inversion of the edges, thus narrowing the arterial canal. For the same reason one should avoid too close and unnecessary suturing. The soft parts are then closed in the usual manner. The limb is to be kept at perfect rest, and heat applied. Massage or passive motion should be entirely withheld during the first few post-operative days.

The first case that came under my observation was that of an embolus of the brachial artery in a woman suffering from diabetes and arteriosclerosis. When seen by me thirty-six hours after onset of disease there was no pulsation in the brachial artery beginning at the middle part of the arm. At that point a very distinct nodule about a half-inch in length could be felt. This nodule, which was apparently in the vessel wall, could be moved in an upward and downward direction. Distinct arterial pulsation could be felt above that point and none below. The diagnosis of brachial embolus was made and arteriotomy under local anæsthesia was done. The clot was extracted and the vessel sutured according to Carrel's method. Unfortunately, the patient developed a cerebral embolus, followed by death twelve hours later. A report of this case and also of two other arteriotomies subsequently performed by me were published in the May, 1928, issue of the ANNALS OF SURGERY.

A third case, included in this paper, is that of an embolus lodged in the left common iliac. It illustrates very strikingly, from its etiological and clinical course, also from the operative procedure, the most salient points pertaining to our subject.

CASE I.—*Embolus of Left Common Iliac.*—M. B., female, aged thirty-five years, was admitted to the Newark Beth Israel Hospital February 15, 1932, and expired February 18, 1932. The admitting diagnosis was an acute exacerbation of a chronic endocarditis with embolus in the left iliac artery. The woman was very sick when admitted to the hospital. Her condition was of such an emergency nature that immediate operation was done.

Past History.—Patient had suffered from chronic endocarditis with frequent remissions and exacerbations for many years. Several weeks before her admission to the hospital, she had an acute exacerbation of her cardiac condition, which confined her to bed. She was running a septic temperature during that time, and three days before her admission she developed symptoms of cerebral embolism, followed by right-sided hæmiplegia. About ten hours before admission she was seized with severe sharp pain in the left groin, radiating down to the entire thigh and leg. This was followed by a numbness, coldness and cyanosis of the toes. She was unable to move the leg. Dr. Eugene Merliss, who saw the patient in the afternoon of the same day, recognized the condition and advised her immediate removal to the hospital. She was very emaciated. She seemed to be markedly dehydrated and there was a marked impairment of speech, and inability to move her right arm and leg. The skin over the left thigh and leg was cold. Moderate cynosis of toes and dorsum of foot. The remaining part of the limb had a marble-like appearance. There was marked diminution of sensation all along the leg and thigh, and marked impairment of motion. The circulation of the right foot and leg also seemed to be moderately impaired, although pulsation of femoral and popliteal was very distinct. Toes also seemed to be slightly cyanosed.

There was no pulsation of the dorsalis pedis, popliteal or femoral arteries, on the left side. A very faint pulsation was felt immediately above Poupart's ligament, along the course of the external iliac artery. Three inches above that, distinct pulsation could be felt on deep pressure, at about the point of the aortic bifurcation into the two common iliacs. Auscultation, with the stethescope, confirmed the condition. A distinct pulsation could be heard at the aortic bifurcation. No pulsation at Poupart's ligament or below that. On the right side, the pulsation of the popliteal and femoral arteries was very distinct. She complained of very severe pain in the left thigh and leg. The condition of the heart was very poor. Temperature ranged between 101° to 103°. The diagnosis of an embolus of left external iliac was evident. Fourteen hours after onset, under spinal anæsthesia, an incision was made parallel to Poupart's ligament. On the left side the external iliac artery was identified and followed up to its bifurcation into the external and internal iliac. There was no pulsation palpable or visible at the external iliac, near Poupart's ligament. Just above the bifurcation of the left common iliac into its external and internal branches, a large clot could be felt at that region. There was moderate pulsation above that point and none below. The left common iliac was exposed to view and followed up to its origin from the aorta. Two sterile tapes were applied above the bifurcation of the artery, one above the clot and one below.

An incision about one-half inch long was then made in the common iliac artery and a large clot was evacuated. Another incision was then made immediately above Poupart's ligament in the external iliac artery and some more clots were expressed. The intervening segment of vessel between the upper and lower arterial incisions was irrigated with a 2 per cent. sodium citrate solution.

Digital palpation of the femoral artery through an extended incision downward showed that vessel to be thrombosed. With upward massage a number of small clots

were expressed through the lower opening of the common iliac artery. The tapes were then released and blood spurted freely through the upper arterial incision. The vessel walls were then sutured with a fine-eyed needle threaded with vaselined silk. The lower incision was still clamped during this process. After closure of the upper incision, the tape from the lower incision was then removed and blood flowed freely from that opening, but the volume and force were poor. Suspecting that the obstruction was not completely relieved, the sutures of the upper incision were removed but no other clots or thrombis above the upper incision were found. On releasing the tape again, blood spurted very freely from the upper incision. Both incisions in the vessel were then closed. There was distinct pulsation below the bifurcation of the common iliac in both vessels—the internal and external—but the pulsation was not transmitted freely to the femoral artery. It was not visible nor palpable. Further arterial exploration was deemed inadvisable and the abdomen was closed.

Patient was kept first in Trendelenburg position on account of the type of anæsthesia and also on account of the extreme shock in which the patient was in. There was no apparent restoration of circulation on the following day. Pulsation of the vessels of the right leg was very distinct but no pulsation could be elicited either by palpation or auscultation at the femoral artery. The general condition of the patient remained very poor. Temperature rose to 103°. She was incoherent, very restless and in spite of external applications of heat to the limb, the discoloration of the leg increased and signs of gangrene set in. Temperature rose to 106° on the second day. Pulse became rapid and also imperceptible. She was cyanosed and dyspnœic and complained of severe pain in both legs. The circulation of the other foot was distinctly impaired. That was probably due to a general circulatory failure, because the pulsation of the right femoral and popliteal continued to be of good quality. The patient died on the third day following operation. Permission for autopsy was not granted.

I am also including case histories of two other patients that came under my observation recently. These histories are relevant to our subject because they prove definitely the futility of the late operation, the inevitable gangrene following non-operative intervention, and the vascular changes taking place in the lumen of the artery after the lodgment of the embolus.

Case II.—J. E., white, male, aged thirty-six years, was admitted to the Newark Beth Israel Hospital May 15, 1928, complaining of severe pain in the left leg. Five days previously, while playing ball, he was seized suddenly with severe pain in the left leg. He stated that he felt a knotting of the muscles so that he was unable to stand up. Within ten minutes the leg became ivory-white, followed by tingling, numbness and limited motion. He was operated on two days later under gas anæsthesia. From the time of operation up to the time when he came under our observation, the gangrene progressed very rapidly and the leg became almost completely black. The pain persisted.

His past history showed that he was treated at our hospital from November 23, 1926, to January, 1927, for auricular fibrillation and some cardiac decompensation. There was marked improvement in his condition at the time of his discharge (January, 1927), and from that time on until the present onset, he had neither complained of any symptoms or shown any signs referable to his cardiac condition, although his work was moderately hard. He was a rugged and well-developed adult. There is neither dyspnœa nor cyanosis, and no evidence of shock. He looked moderately toxic. The heart is immensely enlarged. There is heaving of the precordium. The apex impulse is in the seventh interspace in the mid-axillary line. The heart sounds are markedly irregular. There is a loud blowing systolic murmur transmitted to the back. There are other murmurs but the exact time of their occurrence is faintly heard in the aortic and pulmonic areas. Aortic second sound is greater than pulmonic second sound.

There is a fresh surgical incision on the posterior aspect of the left leg extending

from the popliteal space to the junction of the middle and upper thirds. There is marked swelling about this area. No crepitation on pressure but there is exquisite tenderness. There is discoloration commencing abruptly at the middle of the leg and involving the entire portion of the extremity below it. The toes are black and cold. The dorsalis pedis arterial pulsation cannot be felt. Above the ankle, the leg shows splotchy areas of black, brown and gray. There is a foul odor coming from the wound. Movement is impaired because of pain. Pulsation of the left femoral artery is distinctly felt just below Poupart's ligament and can be followed down to the saphenous space. No pulsation in Hunter's canal. Some enlarged glands can be felt just below the groin. Pulsation of popliteal artery not felt.

Temperature at time of admission, 103; urine, very slight trace of albumin; blood count: 10,000 leucocytes, with a differential count of polymorphonuclears, 78 per cent.; lymphoblasts, 22 per cent.; hæmoglobin, 78 per cent.; red blood-cells, 3,800,000. With a diagnosis of gangrene of left leg of embolic nature and auricular fibrillation with massive cardiac hypertrophy amputation at the thigh was done. Patient made an uneventful recovery.

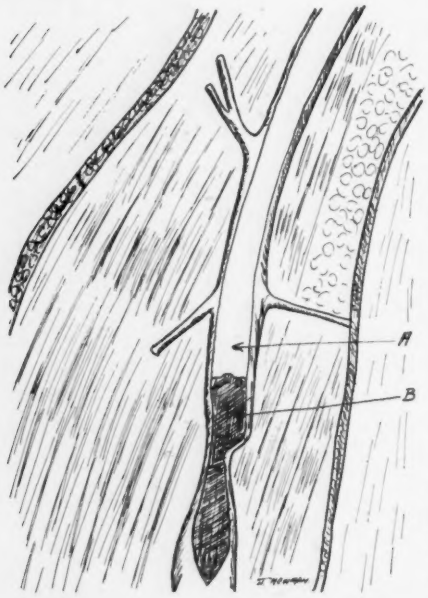


FIG. 1.—Diagrammatic sketch from photograph of femoral artery. A—Injection mass. B—Thrombus.

Pathological description of leg.—(Dr. Asher Yaguda.) Left leg amputated at the junction of the middle and lower thirds. The skin of the foot and lower half of the leg is of a purplish hue and there is a dry gangrene of the toes and the skin covering the dorsum of the foot and the heel. The upper border of the cyanotic discoloration does not end sharply, but gradually shades off into the surrounding normal skin. The whole leg appears mummified.

There is a gaping incision over the posterior aspect of the leg which extends from the popliteal fossa downwards for 19 centimetres over the gastrocnemius muscle. The wound is not closed by sutures and the muscle bulges through the incision presenting a pale grayish œdematous appearance. The incision extends through the gastrocnemius and the soleus muscles and exposes the posterior tibial artery.

Upon opening the popliteal artery, there is seen to be a mixed red and white thrombus filling the vessel up to the point of amputation. This thrombus is loosely but definitely attached to the intima of the artery. At the point of bifurcation of the popliteal artery into anterior and posterior tibials is lodged an embolus which saddles the bifurcation. (Figs. 1 and 2.) This embolus is composed of a white parietal thrombus. The artery above this is dilated. Below this point the arteries are empty and there is a marked venous engorgement due to venous backflow. The popliteal artery and both tibials show slight atherosclerosis but are otherwise negative.

CASE III.—A. R., male, aged sixty-two years, admitted to the Newark Beth Israel Hospital April 1, 1932. He had suffered from cardiac disease for many years. For the past several months he was unable to do any work, being compelled to remain in bed most of the time. Several days previous to his admission to the hosp[illegible] he was seized with sudden sharp pain in his right leg. This was followed by a tingling sensation, numbness and inability to move the leg. The color of his skin assumed a marble-like appearance. No definite diagnosis was made until three days after the onset of his condition, when symptoms of extensive gangrene appeared.

When seen by me in consultation with the attending physician, the foot was entirely gangrenous. Extensive dark-bluish blotches were present on the outer and anterior aspect of the leg. No pulsation could be felt in dorsalis pedis or popliteal vessels. There was distinct pulsation of the femoral artery immediately below Poupart's ligament but none below that point. The circulation of the other leg also appeared somewhat impaired. The diagnosis of embolus of the right femoral was made. Since the gangrene was far advanced, amputation was advised.

A disarticulation of the thigh was done under spinal anæsthesia. Patient reacted

FIG. 2.—Photograph of amputated right leg with femoral artery cut open to show: *A*—Injection mass. *B*—Thrombus. Arrow points to definite constriction and occlusion of the blood-vessel.

well from the operation but died suddenly a week later probably from coronary thrombosis.

The autopsy report and the pathological findings obtained from the dissection of the leg and thigh, as submitted to us by the pathologist, Dr. Asher Yaguda, show several points of interest, relevant to this subject. The specimen consists of the right lower extremity which has been disarticulated at the hip-joint. At the disarticulated end the femoral artery is thickened and shows calcified plaques involving the intima and constricting the lumen. Upon opening the femoral artery, about three inches from the

severed end is a well-formed thrombus which is of recent origin, red in color. A few inches from the beginning of this thrombus and at about the point of bifurcation of the deep and superficial femoral is a constricted portion with a saddle thrombus which shows beginning organization. The artery below this including the popliteal shows a marked atherosclerosis with narrowing of the lumen and thickening of the wall.

Microscopical Examination of sections of the vessel at several levels shows a thickening of the intima with areas of calcification and atheroma formation. The lumen is markedly constricted. Examination of the thrombus shows it to be embolic in origin as can be ascertained from the fact that it is a parietal thrombus which is undergoing some organization. (Figs. 1 and 2.)

The heart weighs 850 grams. There is a marked hypertrophy of the left ventricle with an area of softening involving the posterior wall of the left ventricle at about its upper middle portion. Injection of the vessels with barium shows an atherosclerosis involving both the right coronary artery and the left coronary artery. This atherosclerotic process is particularly apparent in the right circumflex coronary artery after it has given off its lateral ramus and there is a definite blood-clot to be seen at this location. The circulation through the posterior descending ramus therefore is shut off and also in an additional branch which supplies the middle portion of the posterior surface of the left ventricle at the site of softening. The area of softening is much smaller than the area supplied by the occluded right coronary. This is due to the fact that a large number of collateral anastamotic branches have developed. Anastamotic branches can be seen between the capillary and precapillary branches of the same coronary and branches of the right and left coronary arteries. All of the main branches of the coronary artery show some tortuosity and are distinctly narrower than the normal artery would be.

The descending aorta shows a marked atheromatosis and arteriosclerosis. Some of the atheroma show definite evidence of ulceration. The common iliacs are sclerotic and tortuous. On opening the right common iliac a pale thrombus is seen immediately above the bifurcation and extending into the right common iliac and femoral. The thrombus is firm and pale and shows beginning evidence of fibrin formation. The vessel at this site shows marked atheromatosis and arteriosclerosis.

The difference in the condition of the blood-vessels in the two amputated legs, as described in the pathological reports, definitely indicates that early operation in those cases not associated with advanced arteriosclerosis is likely to give a much higher percentage of cures, since the continuity of the arterial canal is more likely to be restored once the obstructing embolus with its associated thrombus is removed. Whereas in cases of arterial emboli associated with advanced arterial sclerotic changes, the lumen of the vessel may be markedly constricted as shown in Case III. Extraction of the obstructing embolus may produce temporary partial circulatory restoration, but this is usually followed by a rapid reformation of a long thrombus which may fill up the lumen of the artery proximal and distal to the point where the embolus was lodged. If the embolus is lodged at the bifurcation into two main branches, the thrombus may extend into both branches, thus preventing the establishment of any collateral circulation. As we shall show later, this assumption seems to be supported by a comparative analysis of the end-results obtained in the two types of cases included in this study.

Statistical study of cases collected from literature.—The total number of cases collected from the literature, for the purpose of studying the end-results, is 129. (Table III.) The average age was forty-nine years; females

and males almost the same. The youngest was a child, seventeen months old, operated on for an embolus in the subclavian artery, supposed to have followed serum treatment for pneumonia. The oldest was a woman, eighty-two years old, who suffered a paralytic stroke previous to the onset of an embolus in the femoral artery, which was removed. Patient was alive and well one year after the operation.

TABLE III

Total number of cases	129
Females	72 or 56.4%
Males	55 or 43.3%
Sex not stated	2
Total	129
Average age (based on 117 cases)	49.0
Female	50.9
Male	49.5
Youngest	17 months
Oldest	82 years

	Male	Female
Youngest	17 months	27 years
Oldest	78 years	82 years

The age incidence, estimated in decades, shows that the frequency of its occurrence is constantly on the increase between the decades of 30 and 40, and 60 and 70, being most common between the ages of 50 and 60. (Table IV.)

TABLE IV

Ages in Decades

1–10	1
10–20	1
20–30	6
30–40	23
40–50	26
50–60	32
60–70	28
70–80	9
80–90	1

There is very little difference in age incidence between the two sexes.

Of the vessels affected, the most common is the femoral (52 or 40.3 per cent). Next in frequency are the brachial and common iliacs. (Table V.) The least commonly affected are the radial and posterior tibial.

Aorta.—There are eleven cases of aortic obstruction by embolus in this group, six of which are males and five females. The ages vary from thirty-seven to sixty-eight. Of these eleven cases, three were not operated upon.

TABLE V

Vessels Affected

Aorta	11 cases
Subclavian	2 cases
Axillary	7 cases
Brachial	19 cases
Radial	1 case
Common iliac	18 cases
Internal and external iliac	5 cases
Femoral	52 cases
Popliteal	12 cases
Anterior and posterior tibial	2 cases
Total	129 cases

Symptoms of obstruction, however, were very distinct and autopsy showed a movable clot above the aortic bifurcation in every case. Two of these patients died within twenty-four hours after the onset of the disease, and one died from a terminal pneumonia, seven days later. Of the eight operated cases, there were two cures; one was operated upon two hours and the other six hours after the onset of symptoms. One of these operated cases was well one year after the operation and the other died three weeks later from embolism of the right innominate artery, but the circulation was completely restored in both legs immediately after the operation and remained in good condition until death. In the six cases that died, operation was performed between a period varying from one hour to fifty hours. Post-mortem examination in three of these cases showed obstructive thrombi at the aortic bifurcation in two, and thrombus in external iliac and femoral artery in one.

The incidence of aortic emboli in the male in this group is greater than that of the female, whereas in our total number of cases, the female element predominates (seventy-two of the former to fifty-five of the latter). E. Hesse,[26] in a study of seventy-two cases of aortic obstruction by thrombi or emboli, questions the previously accepted belief that females are more likely to suffer from aortic obstruction than males. In a study of his group of cases, he finds that the male element predominated in embolic obstruction; twenty-five out of forty-three cases (57 per cent.) were men and eighteen (43 per cent.) were women. On the other hand, out of seventeen, aortic obstruction caused by thrombus formation within the vessel, five (29.4 per cent.) were men and twelve (70.5 per cent.) were women.

CASES OF AORTIC EMBOLISM

CASE I.—Male, aged fifty-nine. Valvular heart-disease. Patient was not operated on, although the diagnosis was definite. Died three days after onset of disease. Autopsy showed gangrene of one-half of the intestinal tract. Freely movable embolus was found at the bifurcation of the aorta. Many soft thrombi were found distal to the embolus, in the iliac and femoral vessels.[7]

Case II.—Male, forty-one years old, suffered from cardiac disease for many years. Previous operation for goitre, twelve years ago; laparotomy for ulcer of stomach, five years ago; palpitation on exertion last two years. Was seized with a sudden sharp pain on the morning of December 1, 1929. The pain was very sharp, mostly in the sacral region, radiating to both legs. Legs became blue and cold, and the pain increased in severity. He was operated on six hours after the onset of symptoms under chloroform and ether anæsthesia. An embolus was extracted, the circulation restored and patient dismissed in four weeks. Two and one-half weeks later, he developed a thrombosis of the right lower leg and symptoms of pulmonary embolism. These symptoms subsided within eight weeks. Five months after operation, there was no cyanosis or œdema of leg. One year later, the general condition was good, complaining only of pain in the right calf, after walking a long distance.[15]

Case III.—Female, aged fifty-six, suffered from myocarditis and mitral regurgitation. Operated on fifty hours after onset of symptoms under ether anæsthesia. Result: No restoration of circulation. Death twenty-four hours after operation.[41]

Case IV.—Male, aged thirty-seven, suffered from heart-disease. Was operated on for an embolus at the bifurcation of the aorta twelve hours after the onset of the disease. Patient died twelve hours after operation. Post-mortem examination showed dark red thrombi extending into external iliac and femoral arteries.[46]

Case V.—Female, aged sixty-two, suffered from diabetes, thyrotoxicosis and marked cardiac disturbance. Patient was previously operated on for an embolus of the right femoral, four hours after the onset of symptoms. On the fifth day following operation, patient felt an agonizing pain in the middle of the back and both legs. The skin, about two fingers breadth, above the umbilicus, showed a blotched and marble color. No pulsation could be felt in the vessels of the thighs and legs. The operation was performed within one hour after onset of symptoms under spinal anæsthesia. The operation was done transperitoneally, through a mid-line incision. Aortic bifurcation was exposed and a clot was extracted. Pulsation felt soon after operation, in both legs. Next morning, pain in lumbar region returned, and patient died within twenty-four hours.[50]

Case VI.—Female, aged fifty-eight, suffered from cardiac decompensation. Operated on twelve hours after onset of disease. Embolus found at bifurcation of aorta. Anæsthesia: Local supplemented by general. There was no restoration of circulation, and patient died soon after.[61]

Case VII.—Female, aged thirty-seven, suffered from cardiac decompensation, which was aggravated by pregnancy of eight months' duration. She was operated on under general anæsthesia. Bilateral incisions were made over the femorals and iliac vessels. An attempt was made to extract the clot, which was only partially successful. There was no restoration of circulation and patient died three days after operation. Autopsy showed an obstructive thrombus, about 1½ inches in length, at the bifurcation of the aorta. There was gangrene of the left foot and leg and right foot. This partial circulatory restoration has probably taken place through some collateral circulation, which was established after the embolus had lodged in the aorta.[63]

Case VIII.—Male, aged fifty-seven, convalescing from a bronchopneumonia, complained of abdominal pain simulating appendicitis, followed by coldness of both legs and loss of motion. Admitted to the hospital on the same day with a diagnosis of embolism of the abdominal aorta. A median laparotomy incision was made under ether narcosis; the aortic bifurcation was exposed and an incision 3 by ¾ centimetres was made into the vessel, and the embolus was spontaneously expelled through the incision. Both iliac arteries were explored and found patent. Patient died on the following day and autopsy showed that the embolism was caused by a thrombus from an ulcerative endocarditis.[66]

Case IX.—Male, aged forty-five, gave a history of repeated attacks of gall-bladder colic and jaundice; some suspicion of cardiac disease. Cholecystectomy was done under spinal anæsthesia. Five weeks after the operation, patient felt a sudden pain in the lower part of abdomen, radiating to the flanks. This was followed by tingling and

numbness of both legs, and loss of motion. The skin assumed a marble-like color; diagnosis of embolism at aortic bifurcation was made. Patient sank rapidly into coma, and died the following day. No embolectomy was done. Post-mortem examination showed a large clot at the aortic bifurcation.[75]

Case X.—Female, aged forty-eight, cardiac. Developed sudden pain in the right groin, back, and both lower limbs; gangrene in right leg, followed by amputation. Died six weeks later of terminal pneumonia. Autopsy showed embolus at bifurcation of aorta, extending into both common iliacs, causing complete obstruction on right, and partial on left.[81]

Case XI.—Male, aged sixty-eight, operated on for hernia. Five days after operation, developed auricular fibrillation. Fifteen days after operation, there was a sudden pain in right foot, followed by marble-like appearance of leg and foot. No tibial or femoral pulsation could be felt; left limb was also cyanosed. Operation performed two hours later under sodium amytal anæsthesia; an abdominal incision was made; five-inch blood-clot was milked down to the femoral vessels. This was followed by a slow stream of blood, but there was no pulsation after the closure of the vessel. Again milking the common iliac vessel near the aorta, the embolus was shot out, followed by forcible stream of blood. Circulation was restored in both feet immediately after the operation. Three weeks later the patient went into coma. There was no pulsation of the right subclavian and right carotid. Diagnosis of embolus in the right innominate artery was made, and patient died ten hours later; no autopsy.[20]

Arteries of the Upper Extremities.—For the sake of brevity, we are including under the classification of arterial embolectomies performed on the blood-vessels of the upper extremity—the subclavian, axillary, brachial and radial arteries. Of the twenty-nine cases in this group, twenty-seven were operated upon. In seventeen (63 per cent.) of these cases, the circulation was completely restored and in two (7.4 per cent.) there was incomplete circulatory restoration, necessitating amputation of the index finger in one and thumb in another. The patients were alive and well one year or more after operation. Two of the nineteen brachial cases that were not operated upon slowly regained sufficient circulation to maintain the function of the entire extremity.

VESSELS OF THE UPPER EXTREMITY—SUBCLAVIAN

Case I.—Left subclavian. Male, seventeen months old, suffered from double pneumonia for which 50 cubic centimetres of Mulford's antipneumococcus serum was given. Similar injection was given on the fourth day of the illness. This was followed by convulsions and marked prostration. The left arm appeared livid and cold, from the fleshy part of the shoulder down to the fingers. There was a diminution of sensation, and marked claw-like contraction of the fingers. Diagnosis of embolism of subclavian was made; operation was performed fifteen hours after onset under chloroform anæsthesia. Incision was first made in the brachial but there was no active bleeding. Aspiration of the upper part of the artery was carried out; then a ureteral catheter was introduced into the artery for about four inches, and on withdrawal a clot 3 centimetres long was brought out, and the circulation was at once restored. The incision in the vessel was closed. The child had no fever and there was good circulation of the hand. Patient died two days later from what the author calls "pleuropulmonary sepsis." No autopsy.[60]

Case II.—Left subclavian. Female, aged sixty-two, previously operated on for empyæma of gall-bladder, followed by lung infarct. Operation was performed five hours later. The embolus was extracted from subclavian vessel, followed by complete restoration of circulation and function of arm. Follow-up six months later showed that no

radial pulsation could be felt on the affected side, and no blood-pressure reading could be obtained, either by auscultation or palpation.[25]

VESSELS OF THE UPPER EXTREMITY—BRACHIAL CASES

CASE I.—Embolus of right brachial. Sex not stated; patient's age, forty-six. Cardiac disease and arteriosclerosis. Had an amputation of leg one week previous. Three weeks after onset, pain in the thigh, which was probably also due to an embolus. Seven days after this operation, patient developed sudden pains above right elbow, which extended rapidly into the entire forearm, followed by complete loss of function of hand and forearm.[21]

CASE II.—Embolus of right brachial. Male, aged sixty-three, tuberculous. Operated on twenty-four hours after onset of symptoms under local anæsthesia. No pulsation of radial at the wrist after operation. Gangrene developed and amputation of arm was done ten days later, followed by good immediate post-operative recovery. Died three days later from cardiac dilatation; no autopsy but dissection of amputated arm showed thrombus in brachial artery and thrombosis in the radial.[14]

CASE III.—Embolus of left brachial. Male, aged eleven. Compound fracture of the left humerus. Time of operation or type of anæsthesia not stated. Embolus from radial was extracted. Author states that after removing the clot from brachial artery, he stopped the bleeding from the vessel by application of hot sponges, and no arterial sutures were inserted. There was complete restoration of circulation and function, probably through collateral circulation.[12]

CASE IV.—Side not stated. Male, aged fifty-seven, suffered from chronic endocarditis with mitral murmur. Operated on previously for gangrene of right leg due to embolus at femoral artery, not diagnosed until one week later. Patient developed embolus of brachial for which he was operated on seven days later under novocaine anæsthesia. The pulsation and dilatation of the brachial artery below the incision were immediately restored. Circulation seemed to be reëstablished (successfully). Died one week later from cerebral and common iliac emboli.[9]

CASE V.—Side not stated. Male, aged thirty-four, operated on previously for acute appendicitis. Embolus extracted two hours later under novocaine anæsthesia. This was followed by gangrene of thumb requiring amputation of its terminal phalanx, with marked neurological disturbance of limb, which ultimately cleared up under physiotherapy.[9]

CASE VI.—Side not stated. Male, aged sixty-six, suffered from cardiovascular disease. Operated for hydrocele nine days previous to the onset of the embolism. The embolus was extracted under local anæsthesia. The time elapsed between onset of symptoms and operation not stated. There was complete restoration of circulation and function. Early operation is emphasized for a successful cure by the author.[5]

CASE VII.—Embolus of left brachial. Female, aged forty-six, diabetic, operated on three days after onset of symptoms. At operation, under novocaine anæsthesia, the forearm was cold and insensible, the hand was shriveled and no pulsation below the brachial artery. There was a bifid thrombus extending into radius and ulnar. Gangrene developed; amputation ten days later.[2]

CASE VIII.—Embolus of right brachial. Male, aged fifty-two; coronary disease. Operated for ruptured gastric ulcer. Five days after operation, suddenly began to complain of pain in left shoulder and arm. Six hours later right arm suddenly turned cold and pulseless; operated one hour after that; embolus from right brachial artery extracted; secondary thrombi in brachial and axillary. There was no return of pulsation; patient died ten hours later from multiple emboli throughout the body. No autopsy.[68]

CASE IX.—Embolus of right brachial. Female, aged sixty-nine, suffered from cardiac decompensation and hypertension. Sudden severe pain in right arm. Operated on twelve hours later under novocaine anæsthesia. No pulsation of radial artery after operation. Five days later circulation improved; ulnar pulsation felt. Developed cerebral

embolus on left side, on sixth day with right hemiplegia. Circulation in left arm seemed normal. Patient died seven weeks after operation.[80]

Case X.—Left brachial embolus. Female, aged twenty-seven, cardiac disease. Operated on three hours later under local anæsthesia. Embolus two centimetres long removed; no radial pulsation felt for four hours. Next day there was pulsation. Patient died from endocarditis on seventeenth day. Autopsy confirmed the clinical diagnosis of the cause of death. There was no trace of thrombus reformation in brachial.[79]

Case XI.—Left brachial embolus. Female, aged forty-six, suffered from cardiac disease. Had a previous amputation of leg above the knee, following embolus of popliteal artery. Operation on brachial was done six hours after onset under local anæsthesia. Two weeks after operation, no radial pulsation. Two months later atrophy of muscles; weakness of forearm; *no radial pulsation*, but no gangrene.[74]

Case XII.—Right brachial embolus. Male, aged thirty-nine; symptoms of tuberculosis and convalescing from an attack of pneumonia. Two weeks after crisis, developed acute pain in right arm during the night, followed by exquisite tenderness, and anæsthesia of the finger tips. Right radial pulse absent. Diagnosis of brachial embolism was made. Patient died three days later without any operation.[73]

Case XIII.—Left brachial embolus. Female, aged seventy-two, cardiac. Seized with sudden pain in left arm, followed by flexion contraction of the fingers and inability to move them. One week later, patch of gangrene appeared upon the back of the left forearm. No operation was done but all symptoms, with the exception of muscular contraction, disappeared within two months after onset of disease. Patient died subsequently from cerebral embolism.[72]

Case XIV.—Side not stated. Male, aged seventy-seven, suffered from hypertension. Operated on four hours after onset of disease; type of anæsthesia is not stated. There was complete circulation and function.[57]

Case XV.—Side not stated. Male, aged seventy-three, cardiac. Operated on six hours after onset of disease under local anæsthesia. This was followed by complete restoration of circulation and function. Patient well one year later, but there was no pulsation ever felt in brachial or radial arteries. The circulation was evidently carried on through collateral branches.[55]

Case XVI.—Right brachial embolus. Age and sex not stated. Etiology, cardiac. Time elapsed not stated. Patient was operated on under local anæsthesia, followed by successful restoration of circulation and function. There was no radial pulse felt at any time after the operation. The circulation, in this case, was also carried on through collateral branches.[53]

Case XVII.—Right brachial embolus. Male, aged forty-six. Etiology, alcoholic? Other etiology is not stated. Operated on five hours after onset of disease under local anæsthesia, followed by partial restoration of circulation. There was gangrene of thumb and index finger requiring amputation.[41]

Case XVIII.—Right brachial embolus. Male, aged seventy-eight, suffered from syphilis and cardiac disease. Operated on two hours after onset of symptoms under local anæsthesia. Restoration of pulsation in brachial and radial; good function. Died thirteen weeks after operation from some other cause.[41]

Case XIX.—Right brachial embolus. Female, aged fifty-eight, suffered from diabetes and cardiovascular disease. Operated on thirty-six hours after onset of disease under brachial block anæsthesia. Died six hours after operation from cerebral embolism.[13]

VESSELS OF THE UPPER EXTREMITY—AXILLARY CASES

Case I.—Side not stated. Female, aged seventy, suffered from cardiac decompensation and arteriosclerosis. She was operated on two hours after onset of symptoms under local anæsthesia. The circulation in the arm was completely restored but the patient died a cardiac death, one week later. Autopsy showed wound well-healed; no evidence of gangrene in the affected arm.[22]

CASE II.—Embolus in left axillary artery. Male, aged forty-two, operated on for hernia. The embolus was extracted three hours after onset of symptoms under novocaine anæsthesia. This was followed by complete restoration of circulation and function of arm. Later on a pulmonary embolism developed, from which the patient recovered. Follow-up showed thrombosis of vein of right leg one month after operation. There is a suggestion that this case might have been one of a paradoxical embolus, carried from a thrombus of one of the veins to the arterial circulation by a patent foramen ovale. There was no history of cardiac disease in this case.[30]

CASE III.—Side not stated. Female, aged fifty-three, suffered from a chronic endocarditis and mitral stenosis. She was operated on four hours after onset of symptoms under spinal anæsthesia. Pulsation returned at operation in the radial artery but on the following day patient appeared very ill, and although the tips of fingers were cyanosed, there was still some pulsation at the radial. Two days later there was excruciating pain in abdomen, followed by incessant vomiting and bloody stools. Patient died three days after operation, probably from emboli lodged in the femoral arteries or the aorta. No autopsy.[30]

CASE IV.—Embolus in left axillary artery. Female, aged sixty-two, suffered from biliary colic and cardiac disease. She was operated on for gall-stones and five days after the operation patient experienced sudden pain in the arm; diagnosis of an embolus in the left axillary artery was made; operation performed under gas anæsthesia, twelve hours after onset; clot removed from the lower end of the axillary. Died twenty-four hours later from cardiac failure.[67]

CASE V.—Side not stated. Male, aged sixty, with a history of syphilis and aneurism of aorta. Operated on forty-eight hours after the onset of symptoms under local anæsthesia, followed by complete restoration of circulation and function.[71]

CASE VI.—Embolus in right axillary artery. Female, aged fifty-two, suffered from cardiac disease and arteriosclerosis. Operated on twenty-nine hours after the onset of symptoms under local anæsthesia, followed by complete restoration of circulation and function. Follow-up two months later showed only a weaker pulsation of the radial artery on the operated side.[42]

CASE VII.—Embolus right axillary artery. Female, aged seventy, suffered from cardiac disease. Operated on eight hours later under brachial block anæsthesia. This was followed by complete restoration of circulation and function, in spite of the fact that the radial pulse was not felt immediately after operation. There was some faint pulsation of the radial two days later; normal function of arm and forearm; primary union of wound. Sutures removed eight days post-operative. Ten days later patient developed an embolus of the right femoral, necessitating reoperation, followed by amputation.[13]

VESSEL OF THE UPPER EXTREMITY—RADIAL CASE

CASE I.—Right radial embolus. Male, aged thirty-one. Etiology unknown. Operated on several days or weeks after onset. Anæsthesia not stated; slow but complete circulatory restoration. Follow-up one year later shows good circulation and function.[67]

Location of Emboli with Reference to Upper or Lower Extremity—Right or Left Side.—Key[35] states that "it is impossible to estimate the relative frequency of the lodgement of an embolus between the right and left side, since the number of cases in which the side is stated is not sufficient to form definite conclusions." In his experience, emboli lodge more frequently in the left lower extremity than in the right, and the same thing is true of the upper extremity. The likelihood of an embolus being lodged more frequently in the left arm than in the right is explained by some by the difference in origin of the subclavian arteries on either side. The right

subclavian arising from the innominate—an embolus finding its way into that vessel, if not arrested at the bifurcation—may enter either into the subclavian or the common carotid arteries; whereas, if the embolus passes by the opening of the innominate artery and enters the left subclavian, it is most likely propelled by the blood-stream into the axillary artery. On the other hand, the direction of the arch of the aorta being from right to left, the innominate artery arising from the right side of the arch is the first vessel that an embolus encounters in its course, after being driven off by the blood-stream from the left ventricle. It would therefore most likely find entrance into the lumen of the innominate artery first. However, there is no definite proof that either of these two assumptions has a definite basis.

In our series of twenty-nine cases of embolus of the upper extremity, the right side seems to predominate. (Table VI.) Emboli lodge more frequently in the vessels of the lower extremity than those of the upper. Of the 129 cases reported in this paper, 100 were in the lower extremity and twenty-nine in the upper. The right lower extremity also slightly predominates over the left. The cause of this marked difference in the incidence of emboli in the vessels of the upper extremity as compared with the lower is not definitely known.

TABLE VI

Percentage of Circulatory Restoration in Individual Vessels

Vessel	No. of Cases	Complete Restoration	Partial Restoration
Aorta	11	2 or 18.0%	1 or 9%
Subclavian	2	2 or 100.0%	none
Axillary	7	5 or 70.0%	none
Brachial	19	11 or 58.0%	4 or 21.0%
Radial	1	1 or 100.0%	none
Common iliac	18	5 or 27.8%	4 or 22.0%
Femoral	52	15 or 28.8%	3 or 5.7%
Int. and ext. iliac	5	2 or 40.0%	1 or 20.0%
Popliteal	12	5 or 41.6%	none
Ant. and post. tibial	2	1 or 50.0%	none

It may not be unreasonable to attribute this difference to the assumption that when an embolus is propelled from the left ventricle into the aorta, the blood-stream is of sufficient strength to carry it rapidly past the orifices of the vessels of the upper extremity, arising from the arch of the aorta to the left curve at the beginning of the descending portion, where it is deflected downward into the abdominal aorta, until it reaches its bifurcation into the two common iliacs.

The respiratory phase, which is present at the time when the embolus passes through the arch of the aorta, is also given by some[25] as a determining factor in the location of the embolus with reference to the upper or lower extremity. Here, again, these are merely assumptions for which definite physiological proof is lacking.

Arteries of the Lower Extremity.—Of the eighty-four vessels of the lower extremity upon which arteriotomy was performed, twenty-eight (33

per cent.) had complete circulatory restoration and eight (9.5 per cent.) regained only partial circulation. Comparing the operative end-results in these two groups of cases, it is evident that the operative end-results are much more favorable in the vessels of the upper extremity than those of the lower, 63 per cent. of complete restoration in the former, against 33 per cent. in the latter.

In comparing the operative end-results of the vessels of the upper and lower extremities with reference to time elapsed between the onset of symptoms and operation, we find that in the vessels of the upper extremity that were operated on between one and four hours, there was complete circulatory restoration in 70 per cent. of the cases and partial in 14 per cent., as against 60 per cent. complete and 5 per cent. partial, in the vessels of the lower extremity. Nine vessels of the upper extremity were operated on between four and twelve hours, with 55 per cent. complete circulatory restoration and 11 per cent. partial; whereas in twenty-eight vessels of the lower extremity operated on within the same period of time, only 25 per cent. complete and 10.7 per cent. partial circulatory restoration was obtained. (Table VII.)

TABLE VII

Comparison of Operative Results—the Time Element Being the Same

	Upper Extremity		Lower Extremity	
1– 4 hrs.	complete	70%	complete	60%
	partial	14%	partial	5%
4– 8 hrs.	complete	80%	complete	30%
	partial	20%	partial	20%
8– 12 hrs.	complete	25%	complete	22%
	partial	none	partial	5.5%
12– 24 hrs.	complete	66%	complete	18%
	partial	none	partial	13%
24– 48 hrs.	complete	66⅔%	complete	16%
	partial	none	partial	none
48–108 hrs.	complete	50%	complete	none
2 cases	partial	none	partial	none

The variation in the post-operative end-results between the vessels of the upper and lower extremities becomes greater, in favor of the former, as the time elapsed between onset of symptoms and the operation increases. Of six cases in the upper extremity, operated on between twelve and forty-eight hours, complete circulatory restoration was obtained in four (66 2/3 per cent.). In twenty cases of the lower extremity, operated on during the same period of time, there were only four cases (18 per cent.) in which the circulation was completely reëstablished. Two of the vessels of the upper extremity were operated on between forty-eight and 108 hours, and circulation was reëstablished in one (50 per cent.), whereas two cases of the lower extremity, operated on within the same space of time, developed gangrene. In two of the cases of the upper extremity, where no operation was performed, there was partial restoration in both, but there was only partial restoration in one case out of the six non-operated cases of the lower extremity, and in

that case the embolus was lodged in the posterior tibial, where the rich collateral circulation around the knee-joint was probably sufficient to maintain the circulation of the leg. It is definitely shown from these comparative figures that, the time element being the same, better operative results are obtained in the vessels of the upper extremity than in those of the lower. May this difference be explained by the establishment of collateral circulation?

Following up some of the arteriotomy operations of the vessels of the upper extremity, we find that in one of the patients operated on for a subclavian embolus, no radial pulsation and no blood-pressure reading could be obtained on that side six months after operation. In the case of an embolus of the radial artery operated on several days later, a similar condition existed long after the operation. In two cases of axillary embolectomy, followed by complete circulatory restoration, there was no radial pulsation in the radial artery, ten days and two months after operation. In the brachial arteries we find in one case (IX) that circulatory restoration was not complete immediately after the operation since there developed gangrene of the thumb, necessitating amputation. In another case there was gangrene of thumb and index finger, followed by slow improvement and restoration of circulation to the remaining fingers and forearm (Case XLI). In a third case (LV) the follow-up shows patient well one year later. In the fourth case patient showed evidence of muscular atrophy and marked weakness of forearm two months after operation but no gangrene (Case LXXIV). There was no radial pulse left in three of these cases several months after the operation. These four cases were operated on between one and six hours. Lack of radial pulsation is recorded in two other cases of brachial embolectomies where the circulatory restoration was complete, although patients died a week or several days later from emboli in other vessels. All three cases in which the time element was not stated were successful. It is interesting to note that in one case no arterial sutures were used to close up the incision. Bleeding was stopped by hot sponges. It is not likely that circulation in the brachial artery was restored since the arteriotomy opening must have been closed by a clot formation and whatever circulation remained, was probably carried on through the collateral branches. In another case there was no radial pulse felt at any time after the operation, in spite of the fact that circulation was definitely restored. Of the two non-operated cases, one was a female, seventy-two years old—cardiac. All symptoms of embolic obstruction of the brachial artery were present. This was followed by an ischæmic contracture and beginning gangrene, which completely disappeared within two months. The muscular contraction remained. Patient died two months later from hemiplegia. In the second case death occurred three days later from a cerebral embolus, but there was no apparent difference in the two arms and no evidence of gangrene despite the fact that there was no radial pulsation. Collateral circulation must have been established.

(*To be continued*)

SURGICAL DISEASES OF THE SHOULDER BURSAE *

By James Morley Hitzrot, M.D.
of New York, N. Y.

Among the conditions which produce disabilities in the shoulder the bursae about the shoulder-joint play an important part.

The bursae about the shoulder-joint are the subdeltoid with its prolongation beneath the acromion, the bursa over the coracoclavicular ligaments, the bursa beneath the subscapularis and the bursa beneath the coracobrachialis and the shorthead of the biceps. Of these the subdeltoid bursa is the most important. This bursa is intimately connected with the freedom of motion in the shoulder-joint and is closely adherent over the capsule of the joint but in none of the operations I have done upon it, or in none of the dissections after distention of this bursa have I been able to demonstrate any communication with the shoulder-joint. Like all serous cavities, especially the joints, it is lined by a layer of endothelium on a loose areolar structure with a denser outer coat composed of fibrous tissue of greater or lesser density in varying locations, and like all joint cavities it is subject to varying conditions which bring about changes in the bursae walls.

By far the most common cause of disease in this bursa is injury. This bursa is involved in injuires to the acromioclavicular joint, dislocations of the shoulder, fractures of the head, neck, and tuberosities of the humerus; injuries to the supraspinatus and infraspinatus tendons; and to certain less easily determined injuries produced by overuse of the arm, wrenches and twists of the shoulder-joint and by minor blows upon the shoulder region or by falls upon the arm or hand.

With all of these injuries involvement of the bursa is common. This may be the result of direct tearing of the bursal wall with hœmorrhage into the bursa, as in fractures; or an exudative reaction with distention of the bursa by fluid, in acromioclavicular injuries and dislocations; or it may be a milder reaction with only a little exudate but with congestion and adhesion between the bursal layers with some erosion or desquamation of the endothelium, but in all cases with a loss of freedom of motion and cohesion between the synovial surfaces. The later changes produce an adhesive bursitis with finer or denser adhesions within the bursa, hypertrophy of the synovial folds with a villous synovitis, fatty degeneration of these villi and many changes of varying intensity and degree throughout the component portion of the bursa. All these pathological changes go to produce a loss of motion in the joint, produce pain and have been described under the general heading of stiff and painful shoulder.

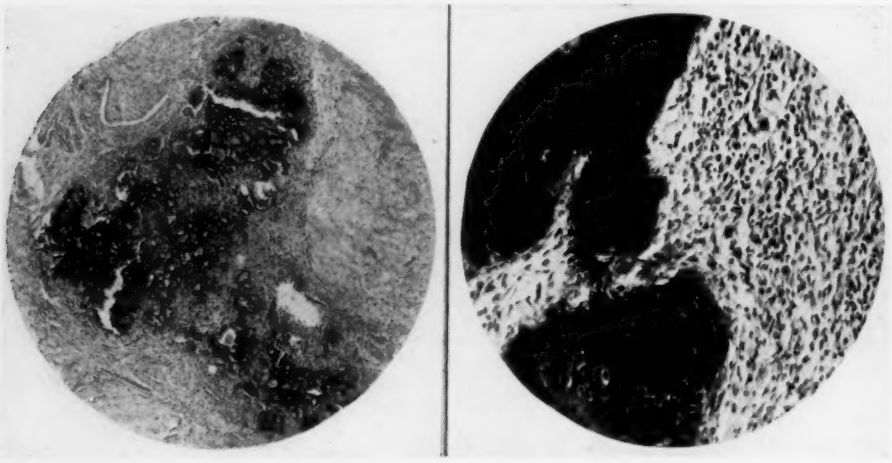
* Read before the New York Surgical Society, January 11, 1933.

Codman, whose communications upon the subject of traumatic subdeltoid bursitis are classical, considers injury to the tendon of the supraspinatus—that is, tears of varying degrees—as the most common cause of inflammatory changes in the bursa.

Codman and Wright studied the "calcified deposits" in the supraspinatus tendon and considered them to have been the result of minor injuries to the tendons with subsequent tissue changes and the deposition of calcium salts.

Wilson (J. A. M. A., vol. xcvii, p. 453, February 7, 1931) considers rupture of the supraspinatus tendon a common injury and in common with other surgeons he has been overlooking this injury and reports a group of complete tears of the supraspinatus tendons and discusses in detail the symptoms and treatment of this condition.

Brickner (Am. Jour. Med. Sci., No. 3, vol. cxcix, March, 1915), states that these calcareous deposits are in the tendons beneath the floor of the bursa, they are circumscribed in their location near the insertion of the tendon but are not enclosed in a sac. The material is composed of calcium oxalate and carbonate, and smaller amounts of magnesium carbonate, and may occur rapidly after the injury as determined by the X-ray. He con-



A B

FIG. 1 A.—Sections through areas of calcification in the supraspinatus tendons which shows cells with the character of immature or altered cartilage cells. Those toward VII o'clock in B look very much like cartilage under the high power.

siders them the result of repeated traumata by pressure of the tendon against the acromion process and the deposition of lime in the poorly vascularized tissue.

Kolliker (Human Histology, London, Sydenham Society, 1853, vol. i, p. 251) describes cartilage cells in the Achilles tendon at its attachment into the os calcis. Because of this finding and from one of my cases (Figs. 1a and 1b) I suggest that the calcification in some of these cases may be due to changes in cartilage cells present in the tendon at its attachment to the bone as a result of the injury to these cells with the subsequent change in the cartilage and calcareous changes subsequent to these injuries. In many areas under the microscope the cells resemble very closely immature cartilage cells in various stages of disintegration and calcification.

Moschcowitz (Amer. Jour. Med. Sci., No. I, vol. cl, p. 115, July, 1915), who studied the histopathology of the material removed by Brickner, considers these changes as a result of tendonitis with necrosis, hyaline degeneration and calcification, and discusses fully the changes seen in the cases he studied and gives an ample discussion of the subject in his paper.

Dollinger (Zentralb f. Chir., vol. lix, p. 579) states that the chief cause of painful shoulder is not due to the bursae but to inflammatory infiltration of the supraspinatus

with "Muskelharte" of this muscle due to the overstretching of this muscle causing tearing of the muscle bundles and pain from this cause. If I interpret his communication correctly he believes that bursal inflammations about the shoulder are rare and that the present importance laid to bursal inflammations is erroneous.

A. S. Taylor (Med. News, June 3, 1905) expresses the belief that in disabilities in the shoulder following a fall upon the shoulder the essential lesion is a palsy produced by overstretching of the brachial plexus, while in those following a fall upon the outstretched hand the plexus is similarly injured by pressure between the clavicle and the first rib.

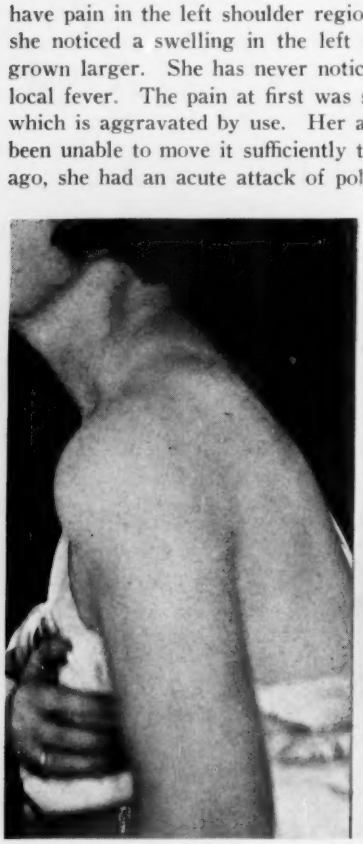
FIG. 2.—Deposit in tendon, culture *Streptococcus hemolyticus*. Culture from root abscess about molar tooth contained same organism. Operation on bursa; extraction of tooth; complete cure.

In a contribution to the subject of Painful Shoulder (Minnesota Med., pp. 148–150, March, 1928) I reported three cases of exudate on the calcareous variety in the supraspinatus tendon in which a hæmolytic streptococcus originating from a tooth in one case, a sinus in another and a hæmolytic aureus originating in an ulceration of the cervix caused an adhesive bursitis of the subdeltoid bursa. (Fig. 2.)

H. Gunther (Deutsche Med. Wchnsch., vol. lvii, p. 1362, August 31) calls attention to the rheumatic involvement of the bursa and tendon sheaths and states that involvement of the subdeltoid bursa with shoulder disabilities is not uncommon in acute rheumatic conditions. In his article he refers to the older writers, Bell and Cloquet, and Fournier

who considered involvement of the bursa as most commonly of gonorrhœal or syphilitic origin.

One case in my series illustrates very beautifully the involvement of the subdeltoid bursa with the formation of rice bodies in a case of chronic joint rheumatism. Mrs. G., aged thirty-eight years, was referred to me in March, 1930, by Dr. L. A. Wing for a swelling in the left shoulder region. About six months before I saw her she began to have pain in the left shoulder region radiating down the left arm. About the same time she noticed a swelling in the left shoulder on the anterior aspect which has gradually grown larger. She has never noticed any sudden increase in size and there has been no local fever. The pain at first was severe but more recently has grown to be a dull ache which is aggravated by use. Her arm has also gradually become more stiff and she has been unable to move it sufficiently to get it over her head. At sixteen, twenty-two years ago, she had an acute attack of polyarticular rheumatism with fever, sweats, *etc.*, which



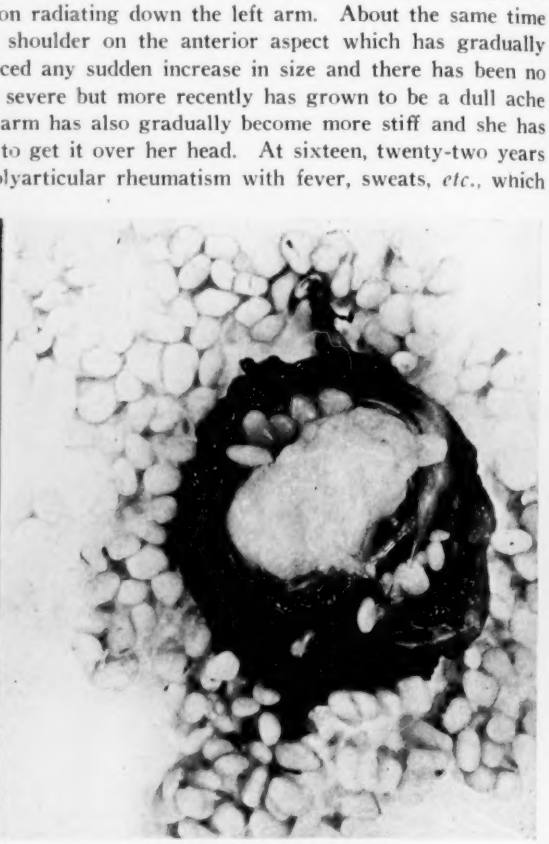


FIG. 3. FIG. 4.

FIG. 3.—Bursitis of left subdeltoid bursa. (See case report, page 4, and Figs. 4, 5 and 6.)
FIG. 4.—Photograph of bursa. Opened with extruded rice bodies. (Same as Fig. 3.)

left both elbows, wrists, knees, and ankles crippled. Since then she has had recurring attacks of joint pain at varying intervals relieved by salicylates. For the past five or six months she has had pain in the back and neck which was most severe when the shoulder began, but which is now less intense and troublesome only from time to time. Her remaining history except for the birth of two children is unessential. (Figs. 3, 4, 5 and 6.)

When I saw her there was a large swelling in the left shoulder region with grating in the shoulder-joint and marked limitation of motion in all directions. This swelling occupying the region of the subdeltoid bursa was tense, seemed fluctuant in character and contained movable bodies which could be more or less definitely defined. Both elbows and wrists were swollen with considerable peri-articular thickening and limitation of motion. Both knees and ankles were also swollen and showed essentially the same changes as in the elbows and wrists. X-ray pictures showed a diffuse arthritis of all the involved joints of the hypertrophic variety. The shadow in the left shoulder was not connected

with the bone. Her tonsils had been removed. The teeth were in good condition. Her heart sounds were normal.

She was operated upon April 2, 1930, under the diagnosis of chronic hypertrophic bursitis of the left subdeltoid bursa, through an anterior incision through the fibres of the deltoid muscle. A part of the attachment of the deltoid to the acromion was divided, removing a portion of the bone in order to expose the bursa. This was large and thick-walled. It was dissected out without difficulty until the upper portion beneath the acromion was reached when it was kicked and a large number of rice bodies escaped. (Fig. 4.) Except for this difficulty the bursa came free from the supraspinatus without great difficulty. There was no communication with the shoulder-joint and the bursa was dissected free in this area with surprisingly little difficulty. The wound was packed with hot saline packs to control the oozing and closed by suturing the acromion process to reattach the deltoid and by closing the divided deltoid muscle. A twisted silkworm drain was placed at the lower angle to take care of the exudate. She made an uneventful recovery and was discharged from the hospital on the fourteenth day with the wound healed.

At first there was limitation of motion at the shoulder with tenderness over the greater tuberosity which disappeared with appropriate physiotheraphy and graded exercises. Seven months after the operation movements in the shoulder were complete and painless in all

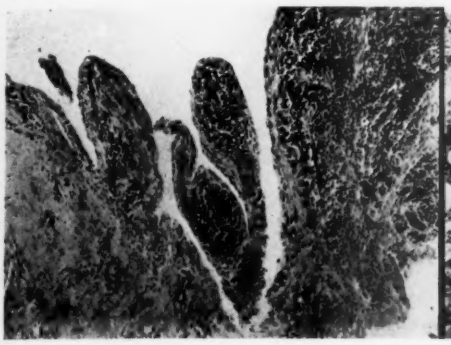


FIG. 5.

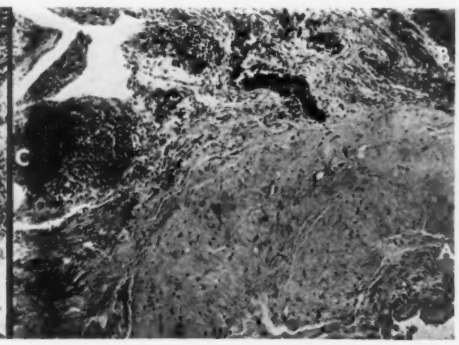


FIG. 6.

FIG. 5.—Showing villous hypertrophy of bursal wall with hyaline degeneration of cells preceding the formation of the rice bodies.

FIG. 6.—A section of the bursal wall showing tendon at A and the bursal wall at B with calcareous deposit at C.

directions. Because of her arthritic pains elsewhere she was referred to Doctor Shuster, who reported that her arthritic condition was due to a nonhæmolytic streptococcus of tonsillar origin. She was treated by him with a vaccine prepared from this strain and on November 11, 1932, he reported her as completely free from arthritic pains for one year.

The pathological report by Doctors Smith and Olcott follows:

Chronic bursitis (subdeltoid) with rice-body formation. Twelve paraffin sections from various parts of the capsule show evidence of a profuse chronic inflammatory process. There are innumerable villous processes covered by a layer of rather flattened cells which are difficult to identify as mesothelial in origin. Each villous stalk has a very profuse capillary blood supply and a fibrous tissue stroma. In the areas where the rice bodies are forming, hyaline degeneration of these villi can be made out, with obliteration of the vessels, and a concomitant mononuclear response. No definite histological evidence of tuberculosis can be made out, although a few atypical areas of monocytic hyperplasia are difficult to absolutely exclude as possibly tuberculous in origin. (Doctor Smith.)

Deltoid bursitis, rice bodies. Specimen is received in two bottles. In one there is a sac which has been opened up but seems to have been about 6 by 5 by 3.5 centimetres in size. It is composed of injected membrane around 0.2 centimetre in thickness. The

outer surface is smoothly white, the inner one contains several thickened papillary areas and some of these resemble rice bodies, while being still attached to the lining. Many loose rice bodies are found. In the other jar there is a little similar tissue which contains some hard areas and at least 100 rice-like bodies. Frozen section shows one of the rice bodies to consist of fibrin in concentric layers. On the inner lining of the bursa there are several projections which consist largely of ovoid cells and also contain many lymphocytes. There is no evidence of tuberculosis. The wall of the cystic areas is made up of connective tissue. (Doctor Olcott.)

Cultures made from the bursa, from macerated portions of the bursal wall and from macerated rice bodies, were sterile.

In many cases the history of injury or of infection is absent. In women I have been asked frequently if driving a closed car with the window open could explain the difficult with the shoulder. As the lesion is in the left shoulder, this being the shoulder exposed to the wind, the coincidence if nothing else is striking.

In other cases Brickner suggests some undetermined metabolic process as the possible cause.

Naturally, with so many different causes, the symptoms of bursal involvement are variable both in the character and extent of the symptoms. Probably the best way to consider them is as acute, subacute and chronic cases in order to get a perspective of the method of onset. The separation into these varieties is subject to many modifications, since an acute case may become chronic and a chronic case become acute, *etc.*

In the acute cases whatever their cause the onset is sudden. The pain is agonizing and completely disabling. It is located in the shoulder region over the deltoid and may radiate down the arm to the fingers and up the neck. Any movement of the arm causes excruciating pain and this pain is out of all proportion to the findings on examination. Swelling in the involved area is rare. Pressure over the region of the greater tuberosity is common and exquisite tenderness in this region is significant. Dawbarn's sign has not been of value as it is impossible to move the arm sufficiently to cause the tender point to disappear beneath the acromion.

Examination of skin sensation is indefinite, there may be areas of hyperæsthesia over the distribution of the circumflex nerve and in the distribution of the branches of the posterior cord down the arm, but these examinations have proven too conflicting and the distribution of the areas too variable to make them of any value in my experience. In a real neuritis these sensory changes are more constant and more definite in their distributions.

Atrophy of the deltoid and the supraspinatus muscles occurs rapidly, the shoulder becomes flattened and the head of the humerus prominent. An X-ray picture is of aid in determining the presence of calcareous deposits in the tendon but does not exclude inflammations of the bursa.

In the subacute cases the onset is more gradual usually with some slight preceding pain and disability which becomes more acute until the shoulder becomes completely disabled and any motion is avoided because of the pain.

The conditions described in the acute cases occur but are less rapid and less severe.

In the chronic cases the symptoms are variable, pain is present after use never particularly severe but as a rule sufficient to be annoying and the patient notices a gradual stiffening and loss of motion in the joint. After use this pain is worse and may be located in the scapular muscles especially if the range of shoulder-joint motion has been interfered with. Examination will show a moderate amount of atrophy of the shoulder muscles, some tenderness over the region of the head of the humerus but the most marked findings are

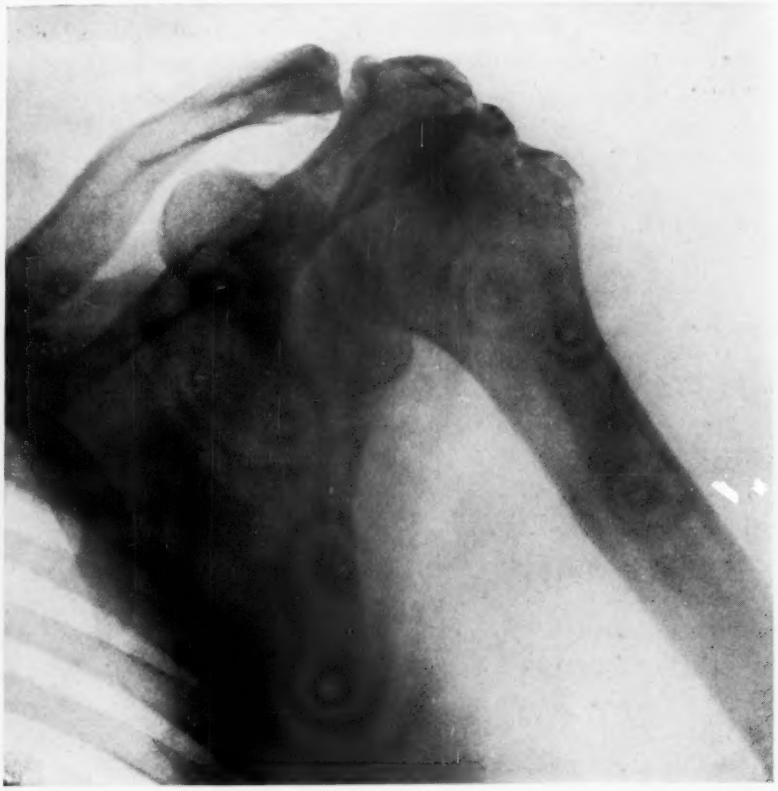


FIG. 7.—Fracture of greater tuberosity by fall on shoulder in man of twenty-eight. Calcareous deposit in supraspinatus tendon; hæmorrhage into bursa; operation; complete range of shoulder motion.

the restricted motion in all directions at the shoulder on both active and passive movements. This restriction may be slight or it may be a complete loss of motion in the shoulder-joint.

Many of the acute and subacute forms become chronic in the manifestations and many of the chronic types may have exacerbations which make them resemble the other types. In fact, so many variations exist that sharp lines of demarcation are often impossible.

In the treatment of a condition produced by such a variety of causes there must be a varied one to meet the conditions. When the condition is obvious

as in fractures or dislocations the treatment of that condition should follow orthodox lines.

In the various injuries involving fractures of the tuberosity, tears of the supraspinatus tendon, operation is indicated with necessary steps to repair the injured area. The early removal of the blood and exudate from the bursa helps materially in decreasing the period of disability. (Fig. 7.)

In the cases less obvious to their cause, the acute and subacute types are best treated by rest in bed, sedatives, especially morphine in the very acute types, and hot moist applications locally.

In my experience dry heat, diathermy and massage increase the pain without resulting benefit during the acute stage. After the more acute symptoms have subsided, which occurs in from three to seven to ten days, dry heat, diathermy, graded exercises, massage and the gradual abduction method advocated by Brickner are indicated. The treatment in each case should be adapted to the case in question.

When the cases show large deposits in the X-ray in the attachment of the supraspinatus, or in recurring attacks with persistent or increasing deposits, operation with the removal of these deposits is indicated as it gives the most rapid relief, is curative in most cases, and the rapid return of function and the freedom from recurring attacks is striking.

When the acute symptoms have subsided and stiffness of the shoulder persists, manipulation of the shoulder under an anæsthetic is indicated. During these manipulations adhesions can be felt to break and motion increases in freedom as the manipulation proceeds. Caution should be exercised in these manipulations not to use too strenuous efforts to free the joint as fracture of the humerus may result.

After manipulation the arm should be kept in the abducted externally rotated position either by suspension in bed or in a plaster splint until the acute reaction and pain following the manipulation have subsided and then treated by physiotherapy, and graded exercises to restore motion.

In cases with coincident arthritis of the shoulder-joint the cases for manipulation should be selected with great care and the prognosis for a satisfactory outcome should be guarded.

Tuberculosis of the subdeltoid bursa occurs only in conjunction with underlying tuberculosis in the bone especially in the greater tuberosity, or by extension from the head of the bone. In the first instance early radical excision of the bone focus together with the bursa is indicated. The operation is difficult and the result leaves much to be desired. The condition is rare. I have seen but one case. Brickner (Amer. Jour. Med. Sci., vol. cxlix, p. 351, March, 1915) had seen only one case and gives one case described by Belhant. In tuberculosis of the head of the bone and shoulder-joint the symptoms and treatment are those of that condition except that involvement of the bursa requires its excision.

Tumors of the bursa are rare. I have seen no primary tumors of the bursa about the shoulder-joint.

Subcoracoid bursitis is very rare. The bursa is situated below the coracoid, beneath the tendon of the coracobrachialis muscle. In this lesion tenderness occurs over the coracoid process or just below it, pain occurs when the arm is abducted and there is inability to hold the arm up in the abducted position because of the pain. There is also pain in drawing the arm forward and upward as in putting on a coat sleeve, carrying any weight, and pulling down upon the arm causes pain in or near the coracoid process. The diagnosis is difficult and as cases with the above symptoms subside with support

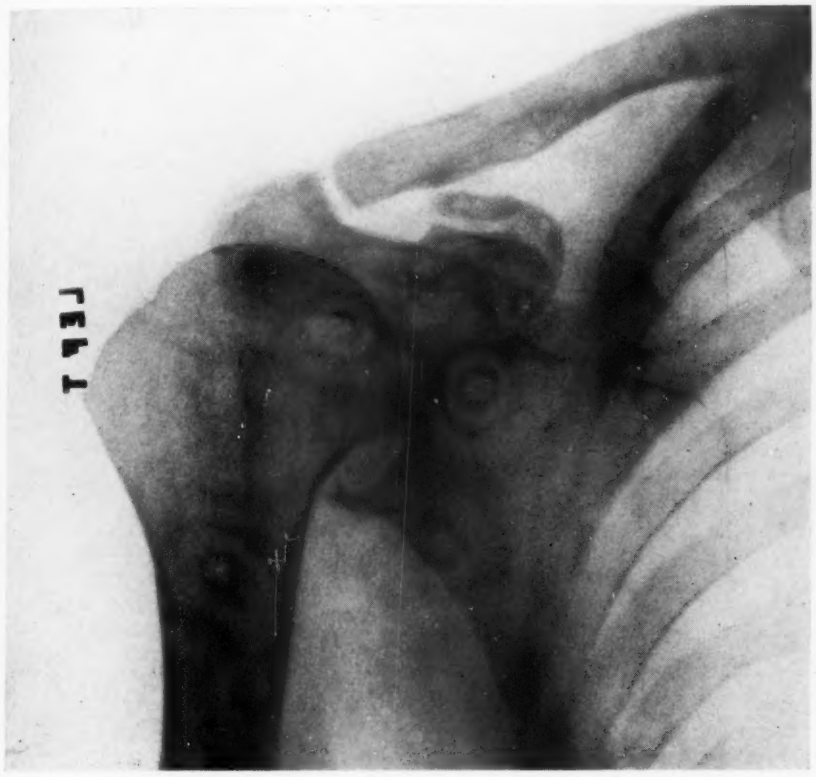


FIG. 8.—Calcification in bursa over coracoclavicular ligaments. Man (fifty-two) fall on shoulder six months previous. At operation calcified body in a sac (bursa?) over coracoclavicular ligaments. (See text, page 9.)

of the arm and heat, the diagnosis can only be probable rather than proven in suspected cases.

Involvement of the bursa over the coracoclavicular ligaments is also rare. I have seen two recognizable cases. In one a man with an acute mastoid following pneumonia which I saw with Dr. J. P. Erskine three weeks after operation for the mastoid, an acute swelling appeared just below the clavicle and above the coracoid which was opened and found to be a suppurating bursa which contained pus which on culture yielded a streptococcus.

The second case was a laborer aged fifty-two years, who six months before I saw him had fallen on the left shoulder. The shoulder was said to have been swollen and there was tenderness over the acromioclavicular joint. When I saw him there was distinct

limitation of motion in the shoulder-joint, especially in rotation, but both active and passive motions were painless. Carrying weight and pulling with the arm caused him pain which he located in the region of the coracoid process and in the acromioclavicular region. Just below the clavicle the coracoid process seemed large and there was deep tenderness there. There was also some thickening over the acromioclavicular joint and a curious crepitation in the two above regions in motions of the shoulder-joint.

The X-ray picture (Fig. 8) showed an arthritis of the shoulder and acromioclavicular region and a curious shadow above the coracoid process which we interpreted as a fracture of that process due to a probable separation of the bone caused by the separation of the ligaments from the coracoid. As he did not improve he was operated upon December 22, 1913, by an incision parallel to and below the clavicle, exposing a curious mass which proved to be a sac containing a calcified body attached by a pedicle to the thick-walled sac which was dissected out with some difficulty. Unfortunately, the specimen, except the calcified body with its pedicle, was lost so that a pathological report is not obtainable. The coracoid process and the ligament were, however, not involved and from its character and location I believe it to have been a bursa with the changes in the wall, villous hypertrophy and calcification of a villous as evidenced by the pedunculated calcified body. Just what relation his injury bore to the pathological process found is problematical and the case is unique in my experience.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD JANUARY 11, 1933

The President, Dr. John Douglas, in the Chair

APATHETIC HYPERTHYROIDISM

Dr. Percy Klingenstein presented an elderly woman, probably seventy years of age, whom he saw for the first time in June, 1932. Her history dated back three years, at which time she began to complain of the following series of symptoms: A dry feeling in her mouth and over her tongue. The condition was not annoying and did not cause any distress; this was not constant but of an intermittent character. There was no associated or neurological symptoms. There were no dermatological manifestations or gastrointestinal manifestations at any time during the present illness. Three weeks ago the tongue became very dry and fissured, with no concomitant bleeding but with pain which has become much more severe during this time. No medication was given or advised and on the advice of her physician she came to the hospital for study. No history of psychic trauma. For the past two years she has been conscious of palpitation when disturbed. No history of excessive perspiration except for two or three severe night sweats during this past winter. No tremor, exophthalmos, hoarseness, or difficulty in breathing, but a sense of increased weakness, loss of nineteen pounds in weight, an increase of appetite, and increased irritability. The tongue showed evidences of atrophy of the papilli. There was no thyroid enlargement, no exophthalmos, no significant tremor. Cardiac status was normal for a woman of her age; her blood-pressure was 154/76. Because of the excessive loss of weight, weakness and some palpitation, in spite of no outward or discernible evidences such as are usually associated with Graves' disease, Graves' was suspected, for the treatment of which she entered the hospital.

Basal metabolism upon admission ranged between plus 52 per cent. and plus 36 per cent. She was placed upon small doses of iodine. The second admission just recently, for exacerbations of her previous symptoms, showed at that time basal metabolic readings of plus 47 per cent. to plus 28 per cent. on discharge.

The reporter called attention to a clinical type of hyperthyroidism recently described by Lahey, in which particularly in the aged the striking signs of hyperthyroidism are lacking. This condition occurs almost exclusively in the elderly and should be suspected in any elderly patient with persistent weight loss and persistent pulse elevation. He also calls attention to the different type of post-operative reaction which these patients may manifest after surgical attack upon the thyroid gland, in which case instead of presenting the features commonly associated in a post-operative thyroid toxicosis or storm, such as delirium and restlessness, these patients sink into an apathetic comatose state.

DR. EMIL GOETSCH said that it seemed unnecessary to him to designate these cases by the term "apathetic," because the apathy is only a symptom of the general syndrome which ends with a worn-out gland and a worn-out patient. The symptoms in these patients are not unlike hyperthyroidism in other respects. He therefore wondered why a separate classification was made. These cases respond to treatment in the same way as any other type of Graves' disease. However, one may not appreciate the degree of hyperthyroidism because of the absence of external activity. The basal metabolic rate of plus 52 is quite high, higher than one would anticipate after hearing the history and examination of the patient. Knowledge of the basal metabolic rate is exceedingly important in these cases to prevent untoward results after thyroidectomy.

DR. WILLIAM BARCLAY PARSONS said that he agreed with Doctor Goetsch in that it was hardly worth while to have a separate classification for these cases, but one must be on one's guard not to miss cases in which the activation of the general nervous system is absent. One does not separately classify cases of duodenal ulcer or of appendicitis that do not present all the text-book symptoms; and the difficulty in diagnosing instances of these diseases where typical symptoms are absent has been commented on numerous times. In nearly all cases of hyperthyroidism there is emphasis on the symptoms from one or more of the systems involved, and there may be absence of symptoms in the gastro-intestinal, cardiac, muscular, as well as in the nervous system. It is, however, of real importance to evaluate the patient's risk before beginning preparation with iodine, in order not to be misled by an apparently good risk on the day of operation.

DR. RICHARD LEWISOHN felt that the great importance of Lahey's observation of apathetic hyperthyroidism was based on the fact that these cases may show serious post-operative complications without offering any of the pre-operative danger signals (nervousness, rapid pulse, and other symptoms). Unless the surgeon recognizes this clinical picture, he may be misled into doing too much surgery (one-stage operation instead of two-stage operation) to the detriment of the patient.

FREE FASCIA LATA TRANSPLANT TO COVER DEFECT IN ABDOMINAL WALL

DR. PERCY KLINGENSTEIN presented a woman, twenty-eight years of age, who was admitted to Doctor Lewisohn's service at Mt. Sinai Hospital about seven months previously with a firm, irregular, non-tender tumor mass in the left epigastric region about the size of a lemon. It moved synchronously with movements of the abdominal wall and became more prominent when the abdominal musculature was tensed. A pre-operative diagnosis of a desmoid (fibrosarcoma) was made. Under general anæsthesia the tumor was exposed; the rectus sheath was adherent to it broadly. The fascia was then incised widely around the presenting mass. Further dissection revealed the tumor had infiltrated the muscle and was adherent to the underlying transversalis fascia. Therefore a portion of the left rectus muscle and the underlying

peritoneum were excised to permit removal of the tumor. The dissection was carried into the linea alba medially. The peritoneum and transversalis fascia were then sewn over in a transverse fashion with chromic gut without undue tension. Medially, chromic gut was used to unite the fascia in the region of the mid-line. Upon the large central fascial and muscle defect, about six by eight centimetres in size, a free fascia lata transplant was applied, which was taken from a previously prepared thigh. This was first anchored by a few chromic gut sutures at strategic points and subsequently made adherent by a continuous suture of fine chromic gut. The strip of fascia was perforated in numerous places to permit serum to escape in the resulting dead spaces. Closure of wound without drainage.

Pathological report was a fibrosarcoma. Macro-specimen consisted of a mass of tissue measuring seven by four by two centimetres. Upon section, the central portion consisted of a circumscribed but not encapsulated mass of firm fibrous tissue. Its anterior surface was covered by fascia, posteriorly by peritoneum.

The patient's wound healed *per primam*. It is now eight months since the operation without evidences of a hernia. The reporter presented the patient as a case in which the use of a free fascial graft has permitted a wide excision of a tumor without the formation of a subsequent hernia in spite of the large sacrifice of a portion of the entire abdominal wall.

Dr. Alexis V. Moschcowitz stated that, as a general rule, he is not in favor of fascial transplantations for the cure of hernia. However, he fully agreed with the views of Doctor Klingenstein that it was absolutely indicated in the case presented by him. Unless something of the kind was done, there was nothing but skin to cover the huge defect caused by the excision of the desmoid. This case is important from another viewpoint. It again proves that the physiological function of muscle is motion and not, as is occasionally ascribed to it, protection. Doctor Moschcowitz is so convinced of the correctness of this view that for a great many years he has abandoned all muscle sutures for the radical cure of any hernia.

SUBTOTAL GASTRECTOMY FOR DUODENAL ULCER

Doctor Klingenstein presented a man, sixty-four years of age, who was admitted to Doctor Lewisohn's service at Mt. Sinai Hospital, with a history that dated back nine years, beginning with an episode of right upper quadrant pain which radiated to the right lower axilla and right shoulder. This pain was accompanied by a temperature of 103°, and chills. There was no jaundice. Three years later there was a recurrence of these symptoms, which lasted about two weeks. Another free interval existed until three months before admission, since which he has had almost daily attacks of right upper quadrant pain, radiating across the epigastrium and to the right shoulder and scapula. In the past two years he also has often had upper abdominal pain, cramplike in nature, two or three hours after eating. Some loss of weight. He was somewhat emaciated with some resistance to palpation in the right upper quadrant of the abdomen, with tenderness in this area just under the costal margin. No tumor masses felt. With the exception of some clubbing of the fingers and a few scattered râles upon auscultation of the chest, the physical examination was otherwise negative.

Under the assumption that the patient was suffering from a chronic cholecystitis and cholelithiasis, X-ray of the gall-bladder was done. This

showed the gall-bladder to fill and empty with dye, but a personal communication from the radiologist that there was probably a diseased gall-bladder, along with the clinical picture, resulted in an operation, with a pre-operative diagnosis of cholecystitis.

At operation, which was done under spinal anæsthesia, supplemented by gas-oxygen and ether inhalation anæsthesia, the upper abdomen was explored through a right paramedian incision. The gall-bladder was found normal. Palpation of the stomach and duodenal region revealed a large penetrating ulcer on the superior and anterior aspect of the first and second portions of the duodenum, with a number of perigastric and periduodenal adhesions. In spite of the large size of the ulcer, it was freely mobile and was practically non-adherent to the pancreas. For this reason resection of the ulcerated area and the antrum of the stomach was decided upon. This was done in the usual manner, securing the cardinal vessels of the stomach, cutting the stomach across between clamps, reflecting back its distal portion, completing the duodenectomy. The duodenum was easily closed. Gastrojejunostomy of end-to-side type, after closing the upper angle of the stomach, was carried out. Wound was closed in layers without drainage. The specimen consisted of a portion of resected stomach measuring sixteen centimetres on the lesser curvature and twenty on the greater. At the distal portion of the stomach there is an area of induration on the inferior surface of the greater curvature saddling it. There were no lymph-nodes found. Straddling the greater curvature about five centimetres from the pyloric ring is a deep ulcer surrounded by raised indurated borders which overhang the distal portion. The base of the ulcer is reddish-gray in appearance and does not show a bleeding point. The ulcer measured along its greatest diameter two by five centimetres. It is thickened and has a coarsely granular appearance.

The patient made an entirely smooth and satisfactory post-operative recovery. He was discharged well, nineteen days after operation.

Dr. Frederic W. Bancroft said that one might assume that hyperacidity in duodenal ulcer is the result and not the cause of the disease. Recent studies in gastric physiology show that during the latter part of digestion bile and duodenal contents are regurgitated into the stomach, thereby reducing the total acidity. When ulcer occurs there is a scar-tissue formation just distal to the pyloric ring and associated with this is pyloric spasm. This will of itself tend to prevent the regurgitation of the alkaline substances, and therefore there will be increased gastric hyperacidity. If the assumption is that hyperacidity is the result of the scar and not the cause the operation of choice should be designed not to remove the greater part of the acid-forming cells but to allow rapid dumping of gastric contents and a satisfactory stoma to allow reflux of duodenal contents into the stomach. For the above reasons he believes that Doctor Klingenstein's procedure in the case reported was well selected, as a resection and retrocolic Polya anastomosis allows the rapid dumping of gastric contents and is well suited to allow the reflux of bile and duodenal contents.

FRACTURE NECK OF THE HUMERUS

Dr. Richard Lewisohn presented a girl who had been admitted to Mt. Sinai Hospital October 11, 1928. She was then three years old. She had fallen down one flight from a fire-escape to the street. There was marked

limitation of motion in the right shoulder. Röntgenographical examination showed a complete transverse fracture through the humerus in the region of the surgical neck with over-riding of the fragments. The lower fragment was displaced mesially. An immediate attempt at closed reduction under X-ray control was unsuccessful. X-ray examination taken the following day showed the same findings as noted above.

An open operation was performed October 15: A three-inch elliptical incision was made over the right shoulder. The lower fragment was displaced upward, forward and inward. The capsule had to be incised in order to expose the fragments properly. The fragments were approximated, a nail was hammered into the head of the humerus from below and the fragments were thus locked together. The capsule was closed by interrupted chromic stitches, the muscles were brought together with plain catgut and a few interrupted stitches of chromic catgut were put into the skin. The arm was placed into an aeroplane splint. An X-ray examination taken the following day showed the fracture of the humerus to be now reduced, the fragments being in perfect position and alignment with the nail is *in situ*. The patient was discharged October 24, but re-admitted November 28 for removal of the plaster splint. A röntgenogram taken on the day of admission showed the same perfect apposition of the fragments, the nail being in the same position as noted above. The plaster splint was removed and passive motion was started. A picture taken two days later showed that the nail had rotated completely, so that its head, which had formerly been distally, now lay proximally in relation to the shoulder-joint, and its point was directed towards the soft tissues of the shoulder. Evidently some rarefaction of the bone had taken place around the nail which was thus hanging loosely in the bone. When passive motion was instituted, the nail dropped out of the bone. The nail could not be felt by palpation. It was removed under X-ray control December 10 through an incision made through skin and muscles. The nail was situated partly subperiostally.

FIG. 1.—Fracture of the surgical neck of the humerus with marked displacement.

The post-operative course was disturbed by a subdeltoid infection, causing a high temperature from December 15 until January 5, and requiring a number of incisions. However, as the infection was periarticular, not intra-articular, motion in the shoulder-joint was not limited. X-ray examination (December 28, 1928) showed that the proper alignment of the fractured ends had been disturbed and the head had again slipped laterally. There was evidence of considerable callus formation. The girl was discharged from the

hospital February 11, 1929. She has been seen at frequent intervals in the return clinic. The functional result is perfect. The right arm has grown normally since the operation. An X-ray film taken recently shows perfect alignment.

Dr. Carl G. Burdick said he thought it was unusual for a surgeon to feel that these fractures in children should have open reduction. Any one who has followed up the results of fractures in children for years, where there has been a considerable amount of displacement, has been continually surprised with the wonderful results. At Bellevue Hospital they have followed from 150 to 200 of these cases with poor anatomical reduction and practically all of them in a few years have had perfect anatomical alignment and function.

Doctor Burdick presented the slides of a child ten years old that had a fracture of the surgical neck of the humerus with mesial displacement and two inches' overriding. The patient was seen five weeks after the injury. On looking at the X-rays all the members of the staff agreed that an open reduction was indicated, but on examination function was only slightly limited and it was decided to keep the child under observation. At the end of four months the X-ray revealed a practically normal bone with very little indication of the previous fracture.

Dr. John Douglas endorsed Doctor Burdick's remarks as to the non-necessity for operation in these fracture cases in children. This was illustrated by a case the speaker had shown some years ago before this society. It was that of a fracture of the lower end of the femur with bad displacement. No traction could be made because of the amount of abrasions and dirt and sand ground into the skin. Reduction under anæsthesia was unsuccessful and therefore it was left alone. There was improvement in a few months and in six months it was almost impossible to tell which leg had been fractured.

ACUTE OSTEOMYELITIS OF THE HEAD OF THE FIBULA

Dr. Richard Lewisohn presented a boy who was admitted to Mt. Sinai Hospital April 19, 1928. He was then three years old. After a sore throat for one week, the mother noticed that the child limped; the temperature was elevated to 106°. The child was very restless during the night. When admitted he was an extremely septic child. Temperature 105°. There was marked tenderness over the head of the right fibula. Blood culture showed hemolytic streptococcus. *Diagnosis.*—Osteomyelitis of fibula with sepsis.

April 20 a three-inch longitudinal incision was made over the head of the right fibula. The peroneal nerve was exposed and held away by a retractor. A subperiosteal abscess was incised and an osteotomy was performed. The head of the fibula contained a small amount of pus. The wound was packed with iodoform gauze. When the leg was lifted up for application of the bandage, a drop foot was noted. Appreciating the significance of this finding, the wound was reopened and carefully inspected. It was found that the peroneal nerve had been severed. Evidently the nerve had slipped out from under the retractor and had been cut, when the incision was lengthened for

the osteotomy of the fibula. The ends of the nerve were sewn together with fine arterial suture material and the wound was redressed.

The high temperature persisted. Two abscesses developed, a subpectoral abscess and a subperiosteal abscess of the left forearm. Both were incised April 28. Following this the temperature subsided. The blood culture was reported negative April 29.

During the next two weeks the patient's temperature ran a moderately febrile course. May 15 the temperature rose again to 104°. A pyarthrosis of the right knee-joint had developed. The joint was opened by two lateral incisions and pus was evacuated. The pus contained hemolytic streptococcus. The wound healed well during the next few weeks. The Willems treatment was employed. The temperature was normal about one week after this operation. Electric reactions showed a degeneration in the nerve supplying the extensor longus digitorum and peroneal muscles.

The boy was discharged from the hospital June 26, 1928. Recent re-examination (December 29, 1932) shows perfect function of the knee-joint and foot.

DR. FENWICK BEEKMAN remarked upon the rapid return of function following the cutting of the peroneal nerve. Several years ago he presented before this society a boy on whom he had done a plastic operation in the axilla for scar contraction. During this procedure the musculospiral nerve was cut but was immediately sutured. In time there was complete return of the function of the nerve. In another case of a baby born with a huge hydroma of the head he had accidentally cut across a branch of the facial nerve. The child now has full function, complete recovery having occurred in thirteen months. Where nerve suture has occurred in children the nerve function comes back more readily than it does in adults. Regarding the pyarthrosis in a number of cases of suppurative arthritis of the knee at Bellevue there was a lesion in either the epiphysis or metaphysis and in all of them results were completely satisfactory by merely draining the joint and not touching the bone. When the tension is relieved the lesion in the metaphysis or the epiphysis is relieved. In one case, however, where the patient became extremely septic, the leg was amputated and on dissection primary osteomyelitis of the epiphysis of the femur was found. So one cannot say that all cases get good results from mere drainage.

CHOLELITHIASIS

DOCTOR LEWISOHN presented a man, thirty-five years old, who was admitted to Mt. Sinai Hospital March 10, 1932. He stated that he had his gall-bladder removed for cholelithiasis five years before at another hospital. After a free interval of eight months the pains recurred, lasting for about three weeks. Again a free interval followed which lasted two years. Recently his attacks have recurred every two months with high fever and jaundice. He was moderately icteric, complaining of upper abdominal pains. A scar in the right upper quadrant showed the site of the previous operation. No ascites. The pain gradually subsided. However, it recurred about one week later. Amylase reaction (38) was markedly elevated, as compared to the normal figure of 5 to 7. This corroborated the impression of acute pancreatitis. White blood-cells numbered 35,000 with 90 per cent. polymorphonuclear lymphocytes.

X-ray examination of the abdomen showed a large ring-shaped shadow near the sacro-iliac synchondrosis, which had the appearance of a gall-stone. Study of this shadow both by barium meal and barium enema showed the mass to be definitely extra-intestinal.

An exploratory laparotomy was performed through the old scar April 4. The free peritoneal cavity was entered. A large fecolith was found in the appendix. (Fig. 2.) The appendix did not show any signs of acute inflammation. The appendix was removed.

After freeing extensive adhesions the common duct was exposed and incised. About fifty stones were evacuated. Some stones were facetted, others non-facetted. After removal of these stones one large stone was felt at the papilla of Vater which could not be pushed upwards. This stone was removed through a retroduodenal choledochotomy. The incision was closed in two layers. A tube was inserted into the common duct, three packings were put around the tube and the abdominal wall was closed.

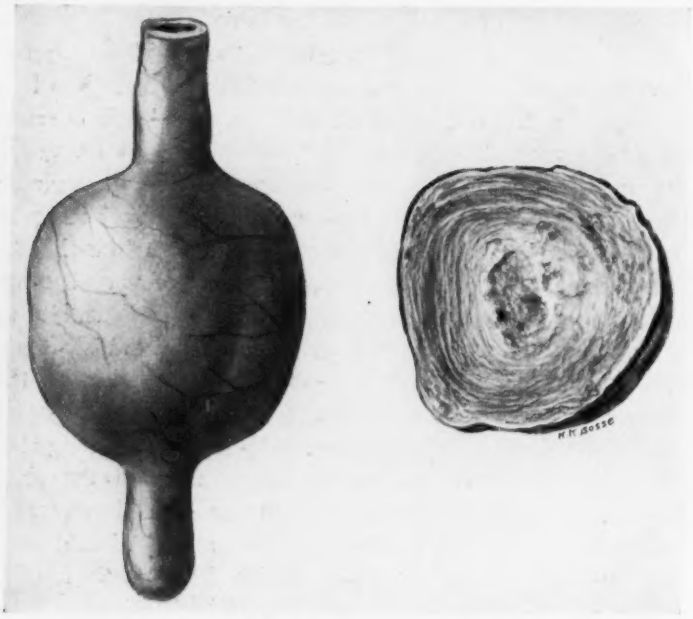


FIG. 2.—Large fecolith in the appendix.

DR. ALLEN O. WHIPPLE said that apparently stones had recurred in this patient after cholecystectomy. That stones may form in the duct after removal of the gall-bladder is a very unwelcome fact. These cases were formerly believed to be rare and in actual number they are rare, but when they do occur they are very trying and distressing. Some time ago Doctor Whipple operated on a typhoid carrier and after cholecystectomy removed three large stones from the common duct. The duct was irrigated carefully and no other remnants or detritus could be found. The patient remained well for eight months and then had symptoms of recurrence. At the second operation thirty-two facetted stones were removed from the common duct.

A second point of interest was the retroduodenal approach. In some cases

that is a very valuable manœuvre. He recalled three cases in which he made the incision through pancreatic tissue to get at the duct. None developed a pancreatitis. If the duct is carefully repaired, with drainage from above, this is not a dangerous procedure. The use of a pliable irrigating catheter is of help in some of these common-duct cases. The stones can be washed out when they cannot be palpated. At the Presbyterian Hospital these silver irrigating catheters are used in cases where there is much detritus, sand or stones.

INTRATHORACIC GOITRE WITH GRAVES' SYNDROME

DR. RICHARD LEWISOHN presented two cases of intrathoracic goitre with Graves' syndrome.

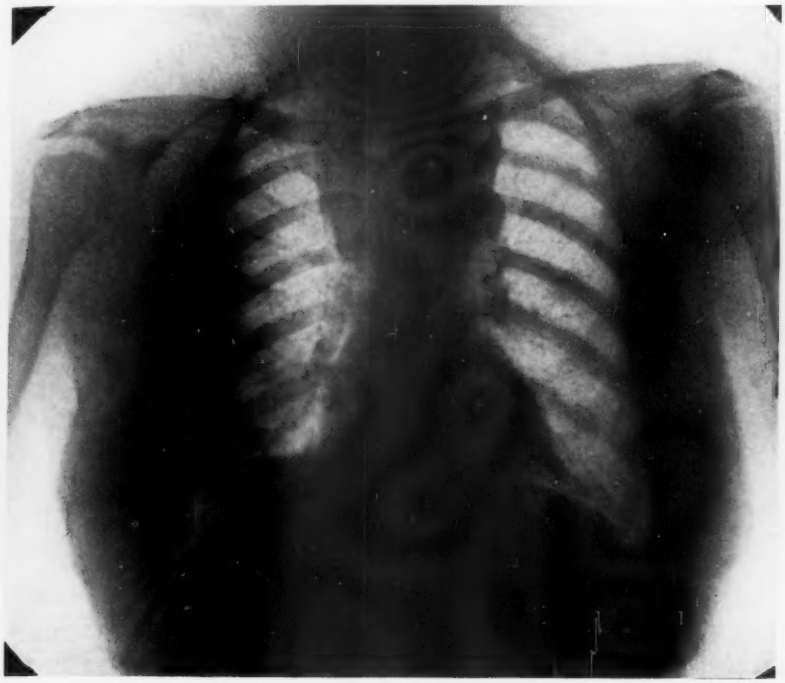


FIG. 3.—Intrathoracic colloid goitre.

CASE I.—A woman, forty-two years old, was admitted to Mt. Sinai Hospital February 3, 1932. She had noticed a swelling of her neck for many years. She had complained for several months prior to her admission of dyspnœa, palpitation, and nervousness. Her present condition prevents her from doing any work. There was evident a large, hard mass on the left side of her neck, which had pushed the trachea to the right side. The right lobe of the thyroid gland could not be palpated. X-ray examination showed enlargement of the left lobe of the thyroid with considerable calcification. The mass reached intrathoracically to the arch of the aorta. The trachea was displaced to the right side of the neck. (Fig. 3.)

After proper Lugolization operation was performed under avertin anæsthesia February 15. Typical collar incision. The long ribbon muscles

of the neck were divided on both sides in order to get proper access. A very large left lobe presented itself. The left upper pole was ligated and cut. The finger was slipped posteriorly down into the mediastinum and a large, partly calcified lobe was lifted out of the superior mediastinum. This lobe was resected and a packing was put into the mediastinum. Closure of wound in typical fashion. Pathological report: calcified adenoma. On the day following the operation the patient showed marked auricular fibrillation. The electrocardiogram showed irregularity due to sinus and also to extra beats. These symptoms subsided in twenty-four hours. The packing was removed on the sixth day. B.M. on discharge, 2 per cent. When seen recently patient stated that she had gained eight pounds and that she is able to work. X-ray of the chest is absolutely normal.

CASE II.—A woman, sixty-one years old, was admitted to Mt. Sinai Hospital October 8, 1932. She had noticed a mass in her neck for forty years, with marked loss of weight (fifty pounds) during the last year. Four

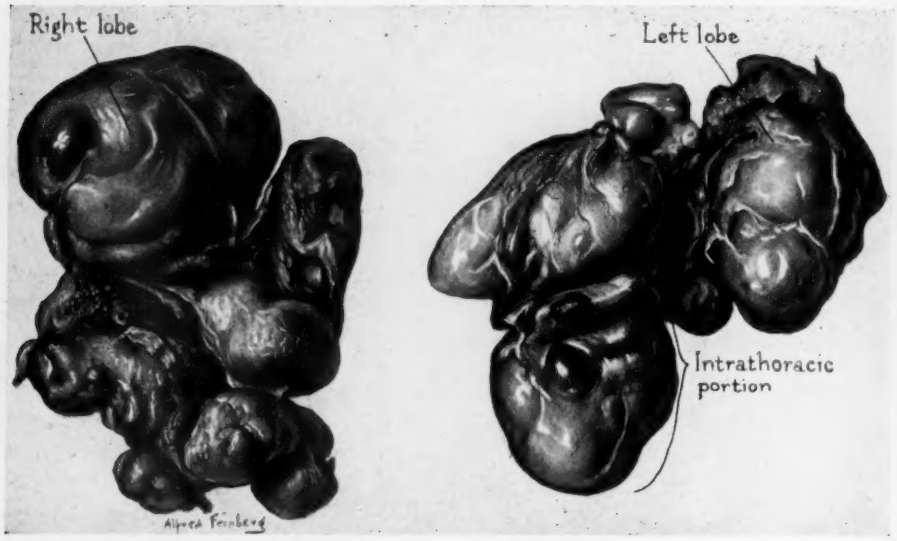


FIG. 4.—Goitre mass after removal, intrathoracic extension.

months ago, following a fall, she felt oppression in the chest. Other symptoms were dyspnœa, tachycardia, and nervousness. She was a thin woman with a fairly large swelling in the neck and definite auricular fibrillation. A röntgenogram showed a large mass in the upper mediastinum which extended below the level of the aorta and outward beyond the parasternal line. Within the shadow there are a number of areas of calcification. The trachea was markedly displaced to the right and compressed. *X-ray diagnosis:* substernal thyroid with calcification.

Under Lugolization the B.M. dropped from 45 per cent. to 16 per cent.

Operation November 3: Thyroidectomy. Typical collar incision. The ribbon muscles were split. A couple of independent large nodules presented themselves. The first one to be removed was the middle lobe, which was partly resected and partly enucleated. It was peach-sized. There were two independent large masses on the left side. The upper mass was resected and enucleated. The lower mass extended deeply into the mediastinum. After ligation of the left superior polar vessels this large mass was gently pulled

out of the chest, adhesions were carefully divided and the mass was enucleated. A large packing was put into the cavity in the mediastinum and the wound was closed in typical fashion. (Fig. 4.) The right lobe was not disturbed. Anæsthesia uneventful. The patient appeared very sick for three days after the operation. The temperature went up to 106°. She was stuporous and had urinary incontinence. She was not restless. Marked fibrillation persisted during this sharp post-operative reaction. Following these anxious days she made a good recovery. The packing was removed on the fifth day. A large sacral decubitus healed under conservative treatment.

Laryngological examination showed a left recurrent paralysis. Her voice is good.

A recent X-ray examination shows a marked decrease in the size of the mediastinal shadow. The trachea is now nearly in the middle line. There are still some calcified areas present on the right side. They may be due to an extension of the right lobe into the upper mediastinum.

Dr. Emil Goetsch said he had never seen an exophthalmic goitre that was intrathoracic. He wished Doctor Lewisohn would explain what he meant by Graves' syndrome in these cases, and whether he was not dealing with toxic adenomata. The speaker did not think the syndrome associated with toxic intrathoracic goitre as in these cases shown was similar to that seen in Graves' disease or exophthalmic goitre. There are no eye signs, no thrills or bruits in the gland and there is an absence of many other evidences of disorder in the sympathetic nervous system. One does, however, find hyperplastic tissue associated with toxic adenoma and this tissue may be responsible for mild eye signs but the diffuse general hyperplasia of the thyroid gland so characteristic of Graves' syndrome is absent.

Dr. William Barclay Parsons said in reference to the nerve weakness following operation in the second case, Doctor Lewisohn had not mentioned if the patient had received a laryngeal examination before the operation. This is of great importance, not only to prove that the cord paralysis existed prior to the operation, but also because hoarseness at times is due to paralysis of the nerve on the opposite side from the tumor. In such a circumstance, extra care must be used not to damage the nerve supply on the side of the tumor, which would result in a bilateral nerve palsy. In any doubtful case, operation under local anæsthesia is indicated. In reference to technic, in Pemberton's original article in the Archives of Surgery, vol. ii, p. 1, January, 1921, there is a clear exposition of the safest technic. First of all, adequate exposure is essential; and secondly, the attack on the gland is planned to avoid bleeding from the inferior group of vessels. He points out the danger of inserting the finger into the thorax to pry up the tumor mass, which practice may be followed by bleeding in the depths while the thoracic aperture is blocked by the goitre. Any one who has suffered this distressing experience, and has followed Pemberton's technic, will never go back to the other method.

Doctor Lewisohn, in closing the discussion, replied to Doctor Parsons that the larynx was examined before operation in the sixty-one-year-old patient, in which there was a post-operative paralysis of the left vocal cord.

These cases of intrathoracic goitre look more dangerous before operation than they really are. A laryngologist is always present at the operation and is ready to introduce a bronchoscope immediately, if it should be necessary.

Pemberton pointed out the value of immediate ligation of the upper pole in order to be able to lift up the mass out of the mediastinum, whereas Lahey added the procedure of slipping the fingers along the posterior wall of the adenoma and thus separating it carefully from the surrounding tissues in the upper mediastinum.

In answering Doctor Goetsch's question Doctor Lewisohn stated that these two cases belonged clinically to the group of hyperthyroidism in spite of the fact that the pathological report classified them as colloid adenomata. Both cases were admitted with an elevated B.M. The second case not only showed marked fibrillation during her pre-operative stay in the hospital, but had a severe post-operative reaction with high temperature and unconsciousness extending over a number of days. A clinical picture not seen in non-toxic goitres.

LARGE INTRATHORACIC GOITRE

DR. RICHARD LEWISOHN presented a woman, forty-three years old, who was admitted to hospital December 21, 1932. She had noticed a swelling of the neck for seventeen years. Considerable dyspnœa was noted in the last few years. The patient did not present symptoms of thyrotoxicosis. The swelling of the neck was very large. B.M. + 3 per cent. It was evidently a large colloid goitre occupying the right lobe, left lobe, and the isthmus. X-ray examination of the chest showed a dense shadow which extended downward from the root of the neck into the thorax and below the aortic arch for a distance of about one and one-half inches. This is probably a large substernal thyroid which has depressed the aortic arch.

Under avertin anæsthesia a long incision was made at the lower part of the neck. Skin flap was pushed back and the long muscles of the neck were split on both sides. Right lobe was then brought forward, and the upper pole was ligated. The right lobe did not extend into the thorax. The left upper pole was then freed and ligated. This pole was cut distal to the ligature. The left lobe extended down into the mediastinum. In order to be able to mobilize this lobe, the large isthmus was cut through between clamps, the trachea was laid bare, and the right lobe and the isthmus resected, leaving only a small amount of goitre tissue behind. After removal of the right lobe and the isthmus, it was possible to mobilize the left lobe sufficiently so that the hand could be carried along its posterior aspect down into the mediastinum and the intrathoracic part of this goitre could thus be lifted up without incurring any bleeding. The left lobe with its intrathoracic extension was then resected, leaving a small stump behind on the left side. The stump on the right side was then sewed over with a few interrupted stitches. The left stump was not sewed over as it was very small. Hemostasis was complete. Bronchial collapse did not occur after the removal of this huge goitre. Breathing was unimpaired. A packing was put into the upper mediastinum. The muscles were sutured with catgut and the skin closed with clips.

The post-operative course was uneventful aside from transitory fibrillation on the second day after operation, which subsided without medication. The packing was removed on the sixth day post-operative.

SURGICAL CONDITIONS OF THE SUBDELTOID BURSA

DR. JAMES MORLEY HITZROT read a paper with the above title for which see page 273.

DR. HENRY W. CAVE asked Doctor Hitzrot how long one should wait after the acute stage of the bursitis had subsided before operation was indicated. Also Doctor Cave felt that in many of these cases the bursitis would clear up without operation. About four years ago Doctor Cave saw a man with bilateral subdeltoid bursitis; X-rays demonstrated calcification in both bursæ. The man refused any operative interference being at the age of sixty, and after a twelve-months' period other X-rays were taken and showed that the calcification of the bursa had disappeared, the patient being entirely free of pain or distress of any kind. Another instance of a left subdeltoid bursitis came under Doctor Cave's observation. Calcification had taken place in this bursa. No operation was performed. X-rays were taken every three months and at the end of about eight months calcification had disappeared and the man was completely free of all symptoms. Doctor Cave admits that there are certain types of bursitis requiring operation, especially where bony fragments have been pulled off around the joint; but he feels many of these cases clear up without operative intervention.

DR. EDWIN BEER asked Doctor Hitzrot in what percentage of subdeltoid bursitis cases he thought an operation should be done. Apparently he has operated on a considerable number of these cases, whereas Doctor Beer felt that conservatism in the treatment of this condition was the proper attitude to take. Wet dressings, gentle massage and diathermy with abduction treatment as recommended by the late Walter M. Brickner usually relieved these patients of their symptoms. The cases of bilateral calcification are often encountered without any symptoms, and frequently one sees symptoms on one side, though the calcification may be more marked on the other side and absent on the side on which the disability and pain are manifest. As Doctor Beer recalled it, Doctor Brickner originally was also rather radical and had operated upon these cases of calcification in the subdeltoid bursa. Before he died, he was much more conservative, and operated very rarely for this condition. With this conservative attitude Doctor Beer was in complete harmony.

DR. DONALD GORDON wished to know what indications were required for operating. In the largest calcified bursa he had ever seen he had believed operation was required but this was not done and the physician who showed the case to him had later reported that it disappeared in one week after three diathermic treatments. Doctor Gordon also wanted to know what treatment was given post-operatively. He had seen a case with bilateral calcification. One side was operated on but became infected. The patient refused operation on the other side and had to receive other treatment. It is easy to operate on these cases but it is not easy to find the calcification and if anything goes wrong one leaves as much pathology as one approaches. Operations on these cases should undoubtedly be done only by a man with considerable experience.

Doctor Hitzrot, in closing the discussion, said that his attitude toward treatment of these cases was like that of others who had operated on them for many years, but do not operate on as many now. He did not operate on the acute cases in which there is a calcium deposit under the floor of the bursa. It is not unusual to have cases recover that use no treatment other than a simple electric pad. There are cases that may or may not show the deposit but later, on taking another X-ray, the calcarious deposit will be found. If the patient is left alone and given graded exercises many of these deposits will disappear, and operation is not necessary. The group that require operation have recurring attacks with residue left for years and recurring disability. In these the deposit does not disappear. In the former cases one may be conservative; it is in the cases with recurring attacks with recurring disability that one must operate. With regard to massage it is contra-indicated because it is extremely painful and makes them worse. Five of the cases in this series were physicians, all of whom had had diathermy, and they said it was so painful they were sorry they ever tried it. Doctor Hitzrot said he had never seen any relief from diathermy. Hot moist dressings in the early, and in the late cases hot dry heat is more comforting than diathermy.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD JANUARY 2, 1933

The President, Dr. John Speese, in the Chair

Calvin M. Smyth, Jr., M.D., Recorder

ADRENAL TUMOR PRODUCING THE ACHARD-THIERS SYNDROME

Dr. Thomas A. Shallow called attention to certain clinical and pathologic manifestations occurring as a result of disorder of the adrenal glands. Much confusion still exists as to the exact pathology present in this disorder. He wished to particularly emphasize that the Achard-Thiers syndrome occurs primarily from disorder of the adrenal gland and that the other ductless glands are secondarily involved as a result of dysfunction of the adrenal.

Hypernephromata springing from adrenal rests situated in the kidney are never associated with any sex variations. Abnormalities in sex development and genital malformations are not limited exclusively to adrenal cortical hypersecretion. Other ductless glands are credited with the power of producing abnormal sex manifestations either in the presence of tumor or hypersecretion. When abnormal sex deformities are present, due to pituitary and pineal glandular disturbances, there are associated with the sex phenomena other clinical manifestations which identify the origin of the disease.

Physiologic variations in the size and morphology of the adrenal cortex have been observed by Stilling in his study of animals during the breeding season. Hager noticed in humans during pregnancy an increase in the amount of hair on the face and body which he attributed to adrenal cortical enlargement. Atrophy of the adrenals associated with loss of hair, diminution in size of the uterus and ovaries and cessation of menstruation have been observed by Karakascheff and Weisel. Karakascheff reported the case of a mother of two children, who at the age of twenty-seven ceased menstruating and died at thirty-nine. At post-mortem there was no hair on the axilla or mons. The uterus and ovaries were very small and the suprarenals almost entirely absent. Weisel describes a girl, aged eighteen, without genital or axillary hair. At post-mortem both adrenals were very small. Microscopically the cortex of the adrenal was normal, but there was noticed a general atrophy of the whole chromaffin system.

The pathologic manifestations of adrenal disorders are:

(1) Pseudohermaphroditism. This is always a congenital defect, the result of some change in embryologic development. It is associated with

changes in body structure and changes resembling the external sex organs of the male type and internal sex organs of the female.

(2) Adrenal precocity occurs as the result of tumor in either the male or female child during the first decade.

When the tumor occurs in a male child there are no female sex characters but an increase in masculinity. This is manifested by increase in strength, increase in stature, development of hirsutism and enlargement of penis and testes. This is well exemplified in a case reported by A. Dingwall Fordyce, occurring in a child two years old. The baby was healthy at birth, breast fed for fifteen months. He weighed 9¾ pounds at birth and 42 pounds at eight months. He never ailed and became fat and strong. At the age of six months, the mother noticed that there was hair on his pubis and that his penis was very big. At the age of eight months a rash was observed on his back which persisted and gradually spread. He had a deep-toned voice and he walked at the age of twenty months. Shortly after this period, he carried a bucket of coal weighing 18 pounds. His systolic pressure was 80 mm. and diastolic pressure 50 mm. A left adrenal tumor the size of an orange was removed. The microscopic examination showed the neoplasm to be an adrenal tumor.

From this it will be gathered that even at the early age of two years, adrenal tumor in the male is associated with increase in strength and the development of sex characteristics of abnormal proportion.

When an adrenal hypersecretion occurs in the female before the age of puberty, the child loses the female characteristics and assumes those of the male; the enlarged clitoris resembling a penis; the development of pubic and axillary hair and precocity.

(3) Adrenal virilism occurring after maturity, according to Gordon Holmes, is manifested by:

(*a*) Atrophy of the uterus and overgrowth of the clitoris.

(*b*) Disturbance of sex functions, manifested by cessation of menstruation.

(*c*) Physical changes—loss of erotic feelings and lack of modesty.

The belief that adrenal tumors cause sex variations in male and female is confirmed by the improvement and the cures resulting from the removal of the tumors. In the cases reported by Gordon Holmes, Fordyce and others, there was return of normal sex characters and function.

(4) Achard-Thiers symptom complex varies considerably from the other syndromes previously described. In this syndrome the pathologic process primarily involves the adrenal in the form of hyperplasia. There is associated with adrenal hyperplasia a polyglandular disturbance. Achard Thiers classified this syndrome as "diabetes of bearded women." At post-mortem, not only do the adrenals show hyperplastic change but also there is associated other ductless gland pathology, namely, pericanalicular sclerosis of the pancreas with increase in the islets of Langerhans, ovarian sclerosis and atrophy, cirrhosis of the liver and colloid hypersecretion of the thyroid, the pituitary

gland being normal. The chief symptom of this syndrome is hypertrichosis of the face of masculine distribution. The other signs of virilism are not present—the breasts and external genitalia are normal, the internal genitalia being characterized by disturbance of menstruation. There is usually amenorrhea or irregular menstruation. These individuals are obese, have glycosuria and a decreased carbohydrate tolerance. Hypertension is observed. These authors were of the opinion that the adrenal changes played an important part in the etiology of this condition, but were probably not the primary cause. (Gloucester, Hill and Greenfield.) As an illustration of this condition the speaker reported the following case:

A white female aged twenty-seven, single. Chief complaints: Obesity of face and lips, one year duration; superfluous hair over the body, one year duration; weakness of arms and legs, seven months duration; lancinating pains in the arms and legs, four months duration; palpitation of the heart and swelling of the ankles; enormous appetite, two months duration.

Physical examination.—Aside from the above group of symptoms the physical examination was essentially negative, except that at times the patient complained of a dull boring pain in the left hypochondrium and loin. Because of her obesity the tumor was not palpable. The X-ray examination disclosed a large kidney on the left side. The X-ray of the skull showed normal sella turcica.

Laboratory findings.—Blood pressure ranged from 140 to 220. Urinary examination negative for diseases of the kidneys. The blood chemistry showed no marked variations from the normal, except for a high carbohydrate tolerance (278 at the end of two and one-half hours). The breasts and external genitalia were normal. Pelvic examination by Dr. P. Brook Bland disclosed no abnormalities.

The syndrome manifested by this patient resembles closely the Achard-Thiers syndrome but differs in some respects. Achard-Thiers questioned the primary site of the etiologic factor. They believed it to be due to adrenal hyperplasia. This patient had a primary malignant tumor which caused the symptom complex. She likewise differs from the Achard-Thiers group in that metrorrhagia with irregular menstruation was a prominent symptom. She was even operated upon for the control of metrorrhagia. An additional variation is the presence of a high carbohydrate tolerance. While these differences may be differences in degree, they are not differences in fact; they emphasize the primary site of the pathologic lesion (adrenal disorder). (Fig. 1.)

Successful removal of the adrenal tumor was not followed by the improvement anticipated. The patient left the hospital in excellent condition and was readmitted under Dr. Reynolds Griffith five months after the operation. While in the hospital the patient still complained of weakness, palpitation, lightning pains in the extremities and obesity. The patient then became glycosuric. The urinary sugar daily present ranged from .3 per cent. to .9 per cent. Secondary anemia appeared. There were changes in the size, shape and staining characteristics of the red blood cells. The X-ray examination disclosed metastases to the lungs. (Fig. 2.)

From these obsservations the speaker concluded that, (1) the Achard-Thiers syndrome is not always associated with adrenal hyperplasia but adrenal tumor can produce this symptom complex; (2) glycosuria was a late manifestation in this patient; it was not in evidence until after the

removal of the tumor; (3) apparently low grade malignant tumor, well encapsulated, metastasized early, even in the presence of apparently complete removal; (4) metastatic growths are capable of continuing this symptom complex after the removal of the tumor.

The pathological examination of the tumor removed showed the specimen to consist of two, somewhat irregularly shaped, rather soft nodular masses of tissue, which together weigh 67 gms. The two masses were separated after removal of the tumor. One mass is slightly larger and is somewhat bean shaped, measuring 6½ by 4½ by 4 cms. It is encapsulated, rather soft, nodular on the surface and contains a small amount of attached fat and ragged tissue. On one surface there is a cavity where the other part of the specimen had been continuous with this. On section, it is composed of a light yellowish, homogeneous tissue which forms distinct nodules in places. One nodule which seems to be encapsulated is composed of much lighter yellow tissue than the surrounding tissue, and measures 2½ cms. in diameter. Small areas are soft and seem to be undergoing necrosis. The other mass which measures 5½ by 4 by 2½ cms., is also rather soft, nodular and of a darker brownish color than the first described

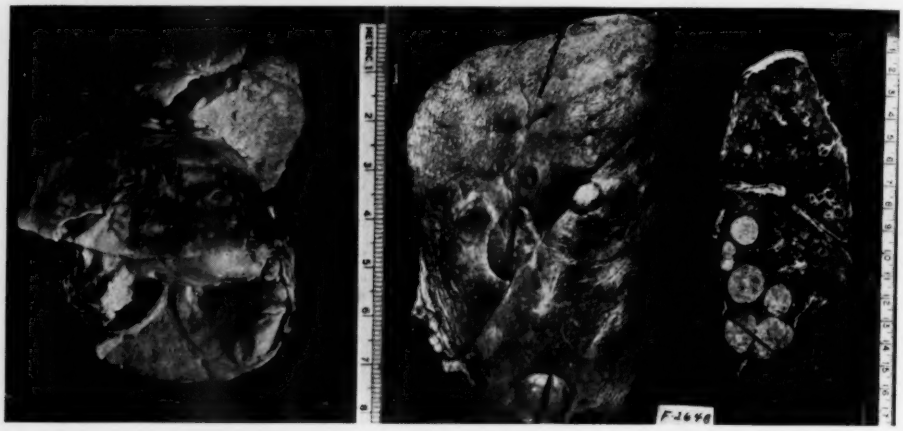


FIG. 1. FIG. 2.

FIG. 1.—Adrenal tumor removed at operation. Complete operative recovery.
FIG. 2.—Showing metastatic nodules in the lungs present five months after the removal of the tumor. X-ray of lungs negative at time of operation.

one. On section, this tissue is very friable, solid and is composed of this homogeneous brownish liver-colored tissue throughout.

Histology—Examination of sections from the larger of the two masses of tissue reveals that it is composed of large, rather clear cells, with relatively large faintly staining nuclei and a large amount of clear cytoplasm. These cells are arranged to form distinct nodules. These is comparatively little intracellular fibrous tissue present and only in small areas is there a suggestion of the normal arrangement of the rows of cells seen in the adrenal cortex. For the most part, the cells have no characteristic arrangement but are loosely held together by a small amount of fibrous tissue stroma in which there are numerous small blood vessels. In some areas the large clear cells predominate and in other areas the cells are small and the cytoplasm contains more granular material. This mass has a very definite capsule but clumps of the cells can be observed in the fibrous capsule. The growth is very vascular in areas with rather large, endothelial-lined spaces separating clumps of the tumor cells. Small areas of necrosis are scattered throughout the tissue.

The small separate mass is composed of somewhat similar cells, but these cells are not so large, the cytoplasm is more granular and contains more pigment and groups of the cells in areas are distinctly oxyphilic. No medullary cells were observed in

any of the sections examined from either mass of tissue, and sections from 8 blocks of tissue were examined from various portions of the two specimens.

The growth seems to be composed entirely of the cortical cells and in some areas the cytoplasm of the cells contains much more pigment and is much more granular than in others, giving the difference in color. Because of the lack of orderly arrangement and the distinct nodules, the lesion is considered to be neoplastic rather than a hyperplasia. While the mass seems definitely encapsulated from the rather bizarre appearance and arrangement of the cells in areas and the vascular nature of the growth, it probably should not be considered entirely benign. *Diagnosis.*—Adenoma of the adrenal cortex.

The speaker said that the case of adrenal tumor just presented is a clear-cut well-defined illustration of Achard-Thiers syndrome. While there may be a question of pituitary involvement in some of the reported cases of adrenal tumor, other clinical manifestations are likewise present which denote the existence of other associated ductless glands.

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EFFECTS OF RÖNTGEN RADIATION OF THE THYROID PARATHYROID GLANDS UPON THE GROWTH OF A GIANT-CELL TUMOR OF THE RADIUS

Dr. George W. Wagoner presented a thirty-one-year-old white man who had been under treatment for a proven giant-cell tumor involving the distal end of the left radius. Surgical removal of the tumor and intensive local X-ray irradiation of the tumor-bearing area failed to prevent recurrence of the growth. Amputation at the mid-forearm was advised. Before resorting to this radical procedure the patient was studied from the standpoint of his calcium-phosphorus metabolism. It was found that the blood calcium was markedly increased (15.9 mg. per 100 cc.) and blood -phosphorus was normal (4 mg. per 100 cc.). Though no thyroid or parathyroid mass was grossly demonstrable the patient was given over a period of fifteen days and in 5 divided doses 1½ erythema doses of X-ray irradiation to the thyroid area.

Following this irradiation the local wrist pain disappeared, the mass became less fluctuant and decreased in size and the blood calcium and phosphorus content gradually approached a normal level and relation. Associated with these changes the basal metabolic rate fell from plus 4 before thyroid-parathyroid irradiation to minus 24 six weeks after completion of irradiation. Seven months after completion of irradiation the basal metabolic rate had risen to minus fourteen. Serial röntgenograms showed a progressive calcification of the tumor mass. The patient was able to resume his work without disability four weeks after completion of local thyroid-parathyroid irradiation.

An examination made seven months after glandular irradiation found the calcium-phosphorus relationship and blood content to be approximately normal, the tumor site to be completely and densely calcified and the patient

free from pain and local disability excepting for slight limitation of wrist-joint motion.

Dr. Thomas A. Shallow said that from the improvement presented in Doctor Wagoner's paper there does not seem to be very much doubt of the beneficial effect of the X-ray in controlling hyperparathyroidism. One must question the advisability of the use of the X-ray in this disorder if there was a palpable thyroid gland present. In event of the presence of a definitely palpable tumor it would seem better to remove the parathyroid gland rather than to subject the thyroid and all of the parathyroids to the effect of X-ray therapy.

Dr. George Wagoner said that this single case does not prove that parathyroid irradiation will cure giant-cell tumor nor did he intend that such inference be taken. Several other cases of giant-cell tumor are now under treatment by parathyroid irradiation alone. The progress being made in these cases is extremely gratifying. As to the preference for irradiation as opposed to parathyroidectomy, he feels that the former is preferable in as much as it is possible to grade the dosage and hence control the degree of "dampening" of parathyroid hyperfunction. Furthermore irradiation can be repeated at frequent intervals over long periods of time if necessary. The simple procedure of irradiation is preferred by patients to that of operative removal of the parathyroids.

REVIEW OF FORTY-TWO CASES OF CARCINOMA OF THE BREAST

Dr. George M. Dorrance presented a preliminary report on an analysis which he had made in 42 cases of carcinoma of the breast treated by radical operation. These patients had been operated upon in a number of clinics, eventually coming under Doctor Dorrance's care at the American Oncologic Hospital whither they had been sent on account of recurrence. Doctor Dorrance was presenting his report at this time without comment on recommendations as to the best plan of treatment to be adopted in breast cancer. He was reserving his opinion until a more complete study of the data had been made. This will be presented at a future meeting of the Academy.

SURGERY OF DIABETIC GANGRENE

Dr. Eldridge L. Eliason pronounced the annual oration on the the above entitled subject for which see page 1 of the July, 1933, issue of Annals of Surgery.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY AND THE PHILADELPHIA ACADEMY OF SURGERY

JOINT MEETING HELD FEBRUARY 8, 1933, AT BELLEVUE HOSPITAL, NEW YORK CITY

LUMBAR SYMPATHETIC NEURECTOMY FOR HIRSCHSPRUNG'S DISEASE

DR. EDWARD J. DONOVAN presented a man, aged twenty-four years, who, in May, 1921, when twelve years old, was first admitted to St. Luke's Hospital, New York, complaining of constipation since birth. X-ray at that time disclosed a dilatation of the colon, but it was thought to be acquired rather than congenital in spite of the fact that no cause for it could be found. He was discharged eighteen days later on cascara and milk of magnesia, and it was stated in the discharge note that his bowels were moving well. He was readmitted one year later with fecal impaction and a history that for several months past his bowels had moved only once or twice a week. Impaction was removed; X-rays taken showed that the sigmoid and descending colon were very large. July 22, 1922, Doctor Bolling removed twenty-four inches of the sigmoid and did a side-to-side anastomosis. Convalescence was uneventful. He was discharged twenty-two days later with satisfactory bowel movements as result of a daily enema. Pathological diagnosis of the colon was megacolon. All the muscular coats were hypertrophied.

Three years after the operation he was again admitted with fecal impaction. He had felt improved for two years after his operation, but now his condition was just as bad as ever. An X-ray taken at this time was reported as showing great dilatation of the colon. He was also shown by Doctor Bolling at the New York Surgical Society about this time to demonstrate the fact that he believed resection in these cases was hardly worth while as the condition recurred promptly in the remaining colon.

January 15, 1932, he was admitted on account of a fecal impaction which was so great that it was necessary to give him an ether anæsthetic to remove the impaction. His X-ray at this time showed the rectum and sigmoid tremendously dilated with considerable dilatation of the descending, transverse and ascending colon. February 9, 1932, a sympathectomy was done. There were many adhesions around the site of his previous operation which it was necessary to dissect. The sigmoid and rectum were so large that it was necessary to mobilize them to remove them from the field of the contemplated sympathectomy. This operation was done under spinal anæsthesia which was a great help in keeping the large intestine out of the field of operation. The peritoneum in the mid-line of the posterior abdominal wall was incised directly over the bifurcation of the aorta. This incision was carried downward over the brim of the pelvis to the left common iliac vein and upward to the origin of the inferior mesenteric artery. The pre-sacral nerve was then found just to the right of the left common iliac vein. In 80 per cent. of the cases that have been operated upon, the pre-sacral nerve exists as three trunks. In 20 per cent. of the cases, these three trunks are fused to form a single nerve. This is the condition, a single trunk, that existed in this case. The pre-sacral nerve was then cut below just before its entrance into the hypogastric ganglia, and dissected upward to the origin of the in-

ferior mesenteric artery as this is the method recommended in finding the inferior mesenteric nerves which lie one on each side of the inferior mesenteric artery. In this dissection from below upward, the connecting branches from the third lumbar ganglia are divided as they pass beneath the common iliac arteries. Branches from the first and second lumbar ganglia are then severed as the nerve is traced upward. About one inch of each inferior mesenteric nerve was then resected with the pre-sacral. The incision in the peritoneum was then closed and the abdomen closed in layers. He had a slight upper respiratory infection with a troublesome cough that bothered him quite a little but it was not considered post-operative pneumonia. His convalescence was otherwise most uneventful. On the third day after operation he received his first enema which was expelled with much force. He was very much pleased with this result and stated of his own free will that it was the first time in his life that he could remember being able to expel an enema. He was given half an ounce of mineral oil t.i.d. and a daily enema for the twelve days that he was in bed with equally good results each day. His bowels moved spontaneously before he received his enema the first day that he was out of bed. He has had mineral oil only since he left the hospital and has one or two very satisfactory bowel movements every day.

CASE II.—A twelve-year-old Jewish girl was admitted to the Babies Hospital, November 17, 1932, for the second time with complaints of abdominal distention, vomiting and failure to move her bowels for the past several days. She was a known case of Hirschsprung's disease, the diagnosis having been made when she was three days old. She was one of twins, the other twin having died at the age of three days, probably from the same condition as her abdomen was very much distended, and she had passed nothing by rectum.*

Since birth this patient, whom he presented, has had to have a daily enema with frequent cathartics and mineral oil. In spite of this treatment, she has often gone several days without having a bowel movement. Three years ago, she was also under treatment for intestinal obstruction due to impacted fæces. By means of numerous hot oil enemata, colonic irrigations and the manual removal of fæces, the obstruction was relieved. Operation was advised at this admission, but was refused. Since that time she has been seen frequently in the clinic.

A sympathectomy was done December 6, 1932, a resection of the pre-sacral with both inferior mesenteric nerves in the usual manner by incising the peritoneum in the mid-line over the promontory of the sacrum. The pre-sacral nerve, which existed as one single cord, was picked up in the region of the left common iliac vein, and dissected upward to the inferior mesenteric artery where about one inch of each inferior mesenteric nerve was removed with the pre-sacral.

The patient had an uneventful convalescence, had a spontaneous bowel movement on the thirteenth day after operation, and was discharged from the hospital on the seventeenth day at which time she was able to expel an enema forcefully.

It is now two months since her operation. Her bowels are moving once or twice a day, and she is having nothing but mineral oil twice a day by

* These cases were reported as Hirschsprung's disease by Dr. Joseph Popper in the New York Medical Journal, December 25, 1920. He was the physician who attended her since she was three days old.

mouth. A barium enema a few days ago shows considerable decrease in the size of the colon. The patient has gained weight, her abdomen is very much smaller, and she is feeling better than she has felt in years.

Dr. Edward W. Peterson (New York), said that three cases of Hirschsprung's disease had been subjected by him to lumbar sympathectomy since January, 1932. In the first and third cases the pre-sacral, the inferior mesenteric nerves, and the left lumbar ganglia were resected; in the second case the pre-sacral and inferior mesenteric nerves, as recommended by Rankin, were resected. The relief of symptoms was most gratifying in all three cases. He had reported these cases on November 9, 1932, before the New York Surgical Society. One of these cases, the most advanced and the least promising, had movements on February 2, 1932. At the present time the bowels are moving normally and naturally each day without any medication, and his abdominal distention is no longer present. The apathy and lassitude, so pronounced before operation, have entirely disappeared. He has gained twenty-five pounds in weight, and several inches in height. His general health is excellent and his whole outlook on life has improved.

Hirschsprung, in 1886, described the disease which has since borne his name as "a condition of congenital high-grade dilatation of the colon, with thickening of all its tunica, especially the tunica muscularis, and retention of large quantities of fecal matter." The dilatation and hypertrophy may affect a part of or the whole of the large bowel. To the cardinal symptoms—dilatation of the colon, abdominal distention and obstipation—may be added languor, apathy, loss of weight, anæmia and general muscular weakness. Occasionally there may be abdominal discomfort, vomiting, fever, and evidences of auto-intoxication. Usually when diarrhœa occurs it is merely the overflow of fecal retention.

The treatment of idiopathic dilatation of the colon in the past, by both medical and surgical measures, has, for the most part, proved unsatisfactory. Following the work of Hunter and Royle, of Sydney, Australia; Wade and Royle, in 1927, reported a case of Hirschsprung's disease, treated by ramisection of the lumbar sympathetic ganglia, with excellent results. Later Judd, Adson, Rankin, Learmouth, of The Mayo Clinic; Wade, Robertson and others gave encouraging accounts of their experience with this operation. There were no deaths recorded. All cases, it seems, were benefited and the end-results, in properly selected cases, were "spectacular." (Rankin.)

There are many theories as to the cause of Hirschsprung's disease, which will not be discussed here. It seems probable that the underlying factor is neurogenic, for there is definite neuromuscular imbalance and dysfunction, and the colon seems incapable of emptying itself of the large fecal accumulations. Section of the lumbar sympathetic nerves causes a break in the hyperactive inhibitory control. The relative safety of the operation and the highly gratifying results obtained by a number of surgeons make this procedure the method of choice in the treatment of properly selected cases of megacolon.

Dr. Thomas A. Shallow (Philadelphia) said that since 1886 when Hirschsprung first wrote his article on this condition, which bears his name, there has been a gradual understanding of the pathological lesion. It is accepted, by most, that Hirschsprung's disease originates as a result of some intrinsic disturbance in the wall of the colon, at the junction of the sigmoid and rectum. As a result of this disorder the sigmoid, some of the colon and indeed, in some cases, all of the colon becomes hypertrophied, thickened and elongated. The management of this condition from the time of its description to the year of 1923 was more or less haphazard. Appendicostomy, iliocolostomy, colectomy and resection of the bowel were performed. Because of the relatively high mortality by these methods of treatment many patients selected the medical plan of treatment.

In 1923, Royle wrote his epoch-making article on the surgical treatment of the sympathetics to control this disorder. Royle believed that the removal of the second, third and fourth lumbar sympathetics removed the inhibitory influence of the sympathetic nerves. That this belief was founded on fact there is no question, numerous cases in literature and some done by myself certainly justify this operation. However, with the increase in our knowledge of the sympathetic nerve system, and with the disease in question, it was found that the lesion was not limited to the sigmoid but also involved, in most cases, the descending colon.

In 1927, Wade, of Australia, developed a new operation for the management of this condition, it was his belief, and this belief has been fortified by subsequent observers, that it was unnecessary to subject the individual to the extensive operation of ganglionectomy. It is now known, conclusively, that the sympathetic inhibitory nerve fibres to the descending colon have their origin in the upper sympathetic ganglia, the semilunar and the celiac plexus, from these plexuses the sympathetic fibres pass along the aorta from the superior mesenteric to the inferior mesenteric artery. Between these two structures the sympathetic nerve system is known as the intermesenteric plexus. It is from this plexus that the inferior mesenteric nerve has its origin. The distribution of the inferior mesenteric nerve is to the middle and descending portion of the colon. Not only does the colon receive the sympathetic nerve supply, of the inferior mesenteric nerve, but it also receives, from the second, third and fourth lumbar ganglia, the pre-sacral sympathetic nerve. The method of formation of the pre-sacral nerve is interesting from an anatomical standpoint but from a surgical standpoint it is no more important than the inferior mesenteric nerve.

Therefore, the plan of procedure for the treatment of Hirschsprung's disease, which includes the removal of the inferior mesenteric nerve and the pre-sacral nerve, is based on sound anatomical and physiological facts.

Doctor Peterson added that at present one did not know how much or how little to do in resecting the lumbar sympathetic nerves in Hirsch-

sprung's disease. Wade advocated, through a long incision in the flank, an extra-peritoneal division of the mesially directed branches and the main chain itself below the fourth lumbar ganglion. Judson and Adson have advised, through a transperitoneal operation, the resection of the second, third and fourth lumbar ganglia on both sides. Rankin and Learmouth believe that resection of the pre-sacral and the inferior mesenteric branches will sever all the nerves to the parts of the bowel chiefly affected, thus avoiding the minor disadvantage of disturbing the neurovascular supply of the lower extremities.

Dr. Frederick A. Bothe (Philadelphia), said that surgeons who prefer the operation that Doctor Donovan has employed in these two cases, to lumbar ganglionectomy, believe that the nerve section is limited to the actual fibres supplying the intestine, that this procedure insures the interruption of all the fibres reaching the distal part of the colon from the thoracico-lumbar sympathetic outflow. The anatomical and physiological reasoning is that first we may attempt to diminish the dilatation of the colon, and leave its motor nerves in less disputed control by division of the inferior mesenteric nerve, and attempt to relieve any opposition to the expulsion of the contents of the bowel offered by the internal sphincter of the anus, by the division of the pre-sacral nerve.

The lower end of the pre-sacral nerve should be clamped before it is cut, to avoid hæmorrhage. Should hæmorrhage occur, difficulty may be experienced in controlling it, and damage to the pelvic plexus and sacral nerves may result. Injury to the pelvic plexus may result in disturbances of micturition, and injury to the sacral nerves may result in a disturbance of the reflex of defecation. He reported a case which was operated upon by Doctor Speese at the Presbyterian Hospital in Philadelphia.

The patient, G. H., was born in the maternity department of the Presbyterian Hospital in 1929. After birth the child did not take feedings well, vomited considerably, and abdominal distention gradually developed. The bowels moved with difficulty and even rectal irrigations were not very successful. Rectal examination revealed a stricture which felt like a membranous band just at the tip of the little finger. A catheter was introduced with difficulty past this constriction. A copious evacuation of foul fecal material was obtained and an abundance of gas was passed with total relief of distention. A barium enema was given with the catheter in place, and it showed a marked degree of dilatation of the entire colon. Subsequently, the infant proctoscope was passed its full length, no evidence of obstruction was found, and the mucosa appeared normal. The child remained in the hospital for a period of five months. On a few occasions it had a natural bowel movement, but daily strenuous colonic irrigations were necessary for a complete evacuation. The child was thought to be too young to consider sympathectomy at this time, so the mother was taught how to give a colonic irrigation and continued this treatment after dismissal from the hospital. Two months later the child was readmitted to the hospital, as home conditions were most unsatisfactory and the mother was unable to care for the child properly. Under hospital management and blood transfusions the general health improved.

He became more alert and active and gained in weight, but the abdominal distention became progressively more pronounced and successful evacuations became more difficult to obtain by colonic irrigations.

When the child was twenty-three months of age, the X-ray report of a barium enema was: "The enema passed without delay or discomfort to the child. The entire colon was greatly dilated, the ascending and descending portions considerably more in proportion to the transverse. At two years of age, the pre-sacral nerve and inferior mesenteric plexus were resected by Doctor Speese. There was some post-operative distention for a few days but on the fourth day the child began to have good results from soapsud enemas and the distention was relieved. Subsequently the child's general condition was definitely improved and the distention was diminished, and on many days natural bowel movements occurred. The patient was discharged thirty-five days after operation. An X-ray study made at this time showed a definite decrease in the size of the descending and transverse colon, and a few haustrations could be seen. There was little change in the ascending colon. One month later the child was readmitted because of improper management at home and a return of the distention. This time the child remained in the hospital for three weeks and at the time of dismissal was again having one to two soft formed stools daily, and the distention was again relieved. Six months after operation the patient was readmitted for follow-up studies. He had grown an inch in height, was much brighter, more alert and active. The abdominal distention had decreased, about 60 per cent. In the course of preparation for a barium enema, he developed a series of convulsions, never regained consciousness, and died in six hours.

POLYPOSIS AND CARCINOMA OF COLON; COLECTOMY FIVE YEARS WITHOUT RECURRENCE

Dr. Henry F. Graham (New York), detailed the history of a woman who was admitted to the Brooklyn Methodist Hospital, November 30, 1927, on account of intestinal disturbances, with discharges of mucus and blood, at intervals during the preceding seven years.

For two months prior to admission she had noticed a tendency to constipation instead of diarrhœa.

At a first operation a large adeno-carcinoma of the sigmoid was drawn out through a lower left muscle-splitting incision and the two limbs of the loop sutured together as in the Miculicz procedure.

The loop was removed nine days later. In addition to the carcinoma several polypi were found in the loop, some of which prolapsed from the upper opening of the colostomy. In a few places carcinomatous degeneration was commencing.

Several transfusions were given and a month after the first operation an end-to-side anastomosis of the terminal ileum to the rectum was made with a Murphy button. By the last of January, 1928, her red cells were normal and the hæmoglobin was 77 per cent. She was allowed to return home for a month and a half. Her stools were somewhat fluid at this time. She gained fifteen pounds in weight and returned to the hospital apparently in perfect health except for occasional blood from her isolated colon.

March 5, 1928, the colostomy was divided; the lower end was closed and the entire colon was removed to a point just about the cæcum. The specimen showed an adeno-carcinoma near the cæcum and numerous adenomata, many

of which were pedunculated, forming true polypi. Two weeks later the remaining cecal pouch and the end of the terminal ileum were removed. There were no polypi in the ileum. She showed wonderful recuperative ability. Every wound, with the exception of the last one, healed without infection.

This patient has remained in good health, a period of five years.

Dr. Damon B. Pfeiffer (Philadelphia), remarked that Doctor Graham's case represented a happy solution of a very difficult problem. The desirability of total colectomy in certain conditions is unquestionable. Especially is this true in diffuse adenomatous polyposis of the colon. In the majority of such cases, cancer of the colon is inevitable. And even before such malignant transformation takes place such individuals are often incapacitated by disturbances of the bowels associated with ulceration and continuous loss of blood, sometimes even massive hæmorrhages. It may be possible in certain cases to deal with single polyps or in others to resect a limited segment of the bowel containing the polyps but it not infrequently happens that the polypoid structures involve the entire mucosa of the colon and the rectum. In such cases the colon must be sacrificed. Palliation may be accomplished by excluding the colon by ileostomy, an offensive condition. It is attractive in such cases to remove the colon and to unite the ileum with the lower segment or rectosigmoid to preserve the natural avenue of discharge. He had undertaken such a procedure only once but unsuccessfully. The patient was a man aged forty-four, who had been subject to intestinal disturbances for several years. Three weeks before admission he had a very severe attack of diarrhœa, pain and bleeding from the bowels. The rectum and colon were seen to be full of polypi. The blood showed hæmoglobin, 53 per cent.; red blood cells, 2,420,000; white blood cells, 9,800. His plan was (1) to make an ileostomy; (2) to remove the colon down to the lower sigmoid; (3) to make an ileo-sigmoidostomy to restore continuity; (4) to fulgurate away through the proctoscope and sigmoidoscope the papillomas of the lower bowel. The ileostomy was made satisfactorily and seventeen days later he removed the colon. In the light of this experience he now believed that a considerably longer interval should elapse between these two steps. There was no difficulty from the operative standpoint and the patient stood the operation well. During the operation the presence of large lymph glands in the lymphatic distribution of the colon and evidence of cellulitis of the retroperitoneal cellular tissue were evident. The patient did well enough for eight or nine days and then became distended, complained of pain and died on the fourteenth day of peritonitis. Autopsy showed no leakage from the bowel and it seemed to him that the infection came from the disturbed retroperitoneal tissues. Later Rankin reported several successful cases of this kind in which he had waited longer between stages. This operation is subject to modifications as in the case just reported but fundamentally it will consist in preliminary drainage of the bowel followed by removal of the whole or the affected part of the colon and by restoration of continuity.

As to the relationship of papillomata or polyps to the development of carcinoma a number of cases of simultaneous, independent carcinomas of the colon in association with polyposis are now on record. He had had no personal case of this sort but had had two cases of independent primary carcinomas of the rectum and sigmoid. In neither of these cases were polyps present in that portion of the colon and rectum which was removed. In his experience, polyps have been associated with carcinoma of the colon or rectum in more than 10 per cent. of the cases. In a case of carcinoma of the rectum which has just left the hospital a large polyp gave considerable difficulty in establishing the function of the colostomy. After the bowel had been opened and the first escape of gas and liquid fæces had subsided, the patient continued to have colicky pains and the colostomy did not functionate properly. Finally, in about a week, she extruded a large globular polyp about three-quarters inch in diameter with a long pedicle attached just inside the opening. The resident removed it and there was no further trouble.

TRANSMANUBRIAL ENLARGEMENT OF UPPER THORACIC APERTURE FOR REMOVAL OF INTRATHORACIC GOITRE

Dr. Emil Goetsch (Brooklyn), reported the following case to illustrate the advantages of a transmanubrial division for the removal of a large intrathoracic goitre:

This patient was a woman aged fifty years, admitted to the Long Island College Hospital May 25, 1931.

About twelve years previous to admission, she began to have severe choking sensations and coughing spells. A mild enlargement of the neck first appeared on the right side of the neck four years later. At the same time the symptoms of pressure and hyperthyroidism became increasingly severe. Seven years later after a period of X-ray treatment, the enlargement diminished in size, with a period of comparative comfort. In November, 1929, symptoms of palpitation and dyspnœa became more severe. Occasional œdema of the legs was noted. She was in bed for five months and lost a great deal of weight. She also suffered fatigue and weakness and severe choking, more upon lying down. Shortly before admission she suffered with a cold which seems to have precipitated a crisis. Coughing, choking, dyspnœa and hoarseness became more severe, being almost constant. Loss of weight and weakness were progressive. X-ray examination of the chest showed a large mediastinal shadow, and the diagnosis of intrathoracic goitre was made.

The neck was broad and thick and showed a globular fullness low in the right anterior triangle just above the clavicle. The larynx and trachea were displaced to the left. Just above the clavicle on the right one could feel the dome of a firm, oval adenomatous mass which extended downwards into the mediastinum. The left thyroid lobe was slightly enlarged and irregular and tender but no nodules were found. A pulse was felt at the pole on the right but no thrill. No increased circulation was noted on the left. The percussion note over the manubrium and along its right margin was dull. Forced respiration produced a definite tracheal stridor. The voice was husky, low-pitched and very weak. A large, globular shadow occupied the right mediastinum, displacing the trachea to the left. The shadow was oval, circumscribed and about the size of a large orange. Examination of the lung fields was negative. The pulse was 100; the blood-pressure 148/80 and the

weight 156½ pounds. Laboratory tests were negative. The diagnosis was of intrathoracic goitre. The patient was given pre-operatively Lugol's solution M.VIII three times a day. She was considerably benefited, the pulse coming down to 92.

Operation April 27, 1931, anæsthesia of nitrous oxide, oxygen and a small amount of ether being employed. The usual collar incision for the exposure of the thyroid was made. The dome of the adenomatous mass on the right was uncovered. This dome-shaped upper pole was the size of a small lemon and projected as it were upwards from the mediastinum. It was dissected free from its attachments to the larynx and trachea in the usual manner. Clamps were then placed on the capsule for the purpose of traction upon the intrathoracic mass. The capsule, however, proved to be very thin and the dome of the tumor, being composed of friable nodules, fractured off from the main mass flush with the clavicle. There was some bleeding at this point and it at once became evident that it was clearly impossible to raise the tumor through the available space in the thoracic aperture. The trachea was displaced to the left and because of its compression against the upper margin of the manubrium there resulted increasing respiratory difficulty when an attempt was made to raise or dislocate the intrathoracic mass. The latter had assumed the shape of a pear, produced by compression of the clavicle and the first rib. By far the larger part of the mass was in the mediastinum below the groove produced by the clavicle and first rib.

In order to gain more space, the manubrium was exposed by a vertical incision downward from the centre of the collar incision. The fascia and tissue of the jugular notch was carefully freed from the manubrium. A finger was inserted behind the manubrium to free its posterior surface of blood-vessels, fascia and possibly pleura. Two perforator-burr trephine openings were made in the body of the manubrium. Through these in turn and over the upper margin of the manubrium a Gigli saw was inserted and by this means a vertical division of the manubrium was readily performed. By means of retractors and with fair ease the two halves of the manubrium were then separated until a gap of about an inch or more was obtained. This gave a striking increase in size of the thoracic aperture and the mediastinal mass was then surprisingly readily brought up into the neck. It was the size of a grape fruit, oval in shape and showed the grooving of the clavicle and first rib. The mass was encapsulated and composed of colloid nodules, many of which showed old fibrous change but no calcification. There was complete atrophy of the former right thyroid lobe. The right recurrent nerve was exposed during the dissection. The isthmus and left lobe were practically normal in size and appearance. A small gauze pack was placed immediately in front of and behind the manubrium and another in the mediastinal cavity. The two halves of the manubrium were brought together by chromic cat-gut sutures of the periosteum and the fascia at the upper border of the manubrium. Throughout there was no great difficulty with respirations and the condition of the patient at the end was good.

In the evening of the day of operation, the patient's speech was definitely better than before operation. The drains and gauze pack were removed within the first forty-eight hours. On the third day following operation, there was some cough and expectoration which soon cleared up. During the following two days, the patient complained of some pain in the region of the manubrium. This was not severe, however. The wound healed normally and on the tenth day a check-up of symptoms revealed that all choking, cough, dyspnœa, palpitation and nervousness had disappeared.

She was discharged two weeks after operation in excellent condition. Nearly two years later, when seen on February 8, 1933, she stated that she had been entirely well since leaving the hospital. She had gained considerably in weight; five pounds over her previously greatest weight. The voice was clear, the so-called asthmatic attacks were entirely relieved as also the previous symptoms of hyperthyroidism. There were no symptoms referable to the division of the manubrium.

Doctor Goetsch stated that he had found no reference to a similar operation for the removal of large intrathoracic goitre which cannot be brought up through the thoracic aperture in the usual manner. It is rarely necessary to resort to this measure, but, as in this case reported, the procedure described became imperative.

Kerr and Warfield* described an operation based on much the same principles, namely, the vertical division of the manubrium and sternum, with raising one-half of the divided sternum and attached ribs, for the exposure and removal of an intrathoracic dermoid.

DR. GEORGE P. MULLER said that as a rule intrathoracic goitre can be removed by simple luxation and excision. As these goitres almost always maintain their blood supply from above, the inferior thyroid should be ligated first. Sometimes alarming hæmorrhage results from the tearing of veins going to the surrounding fascia and hence luxation should not be attempted where much force is necessary to elevate the mass. He had removed the tumor by morcellement several times but this is an untidy operation. In a few cases he had cut away the top of the sternum with rongeur forceps in order to get room for the luxation, and had found this very satisfactory.

Resection of the manubrium and anterior mediastinotomy should find its greatest use in those cases of intrathoracic goitre when the diagnosis from tumors such as dermoids is difficult and where the goitre practically has no connection with the lower pole or isthmus. In this procedure as well as in the luxation of tightly wedged tumors anæsthesia is greatly facilitated by bronchoscopical control.

As illustrative of a typical case he cited the history of a man aged forty-two, who was admitted to the University Hospital, December 14, 1931, on account of dyspnœa and cough which had persisted for three months. Röntgen-ray examination showed a tumor about the size of a lemon behind the right second rib. In October he was given ten deep X-ray treatments over a period of three weeks but because of increasing severity of cough operation was finally decided upon. It was noted that when the patient coughed there was a definite bulging of the lower neck. The basal metabolic rate was plus 15. There was a slight tremor but no tachycardia; the thyroid gland was just palpable but the lower poles apparently could be identified. An electrocardiogram showed frequent ventricular extra systoles, but was otherwise negative.

Fluoroscopical and film examination showed a tumor in the anterior mediastinum displacing the trachea to the left, and posteriorly. Swallowing changed the conformation of the tumor and this is considered an important differential point from aneurism. December 17, 1931, under ether anæsthesia and with a bronchoscope introduced to the bifurcation, usual exposure for

*Kerr and Warfield: Trans. Amer. Surg. Assn., vol. xlvi, pp. 291–313, 1928.

thyroidectomy was done by a low transverse incision. The tumor could be felt but could not be budged nor could the finger be introduced below it. Therefore a T-incision was made, the sternum split to the second rib and outwards to the left and the incision spread. The tumor could then be dislocated upwards and outwards. A pedicle was found prolonged from the right lower pole. This was divided and the mass removed. The parts of the sternum were brought together by an encircling chromic catgut. Two large cigarette drains were placed in the cavity. The patient breathed easily throughout the operation. The specimen measured 9 by 8 by 4.5 centimetres and was a thyroid adenoma (non-toxic).

The patient seemed to be making an uninterrupted recovery when on December 28, the Röntgen-ray disclosed a large shadow equivalent to the shadow of the tumor. This was thought to be a hematoma. Laryngoscopy showed no evidence of tracheal compression, nor interference with phonation. The subsequent course of events justified the diagnosis of a hematoma because a bloody serous fluid discharged until March, 1932, at which time the wound was healed. On November 17, 1932, he was perfectly well and driving a wagon.

A few months prior to the operation on this patient Doctor Muller had attempted to remove a large intrathoracic goitre which was located in the posterior mediastinum after a trans-sternal mediastinotomy. Considerable manipulation was done but the mass could not be brought up and the operation was abandoned. The patient died.

In the average case the exposure suffices to enable the surgeon to dislocate the tumor and if care is taken to prevent tearing of the pleura there should be no serious complications. The cut surfaces of the sternum bleed freely. His experience justified the statement that large intrathoracic goitres with marked tracheal deviation justify the routine use of anæsthesia through the bronchoscope.

BRIEF COMMUNICATIONS

UNILATERAL FUSED KIDNEY

AN ADULT, male, was admitted to the Asbury Hospital of Minneapolis, Minnesota, September 20, 1931, complaining of pain in the back and right side with nausea and vomiting; temperature, 100.3°. Examination revealed a mass as large as a grapefruit in the upper right quadrant of the abdomen; cystoscopical examination showed a normal bladder; normal flow of urine through left ureter, unusual rapidity of flow through right ureter for a time and then final cessation. X-ray showed both ureters passing to right side of body; Skiagraphs revealed great dilatation of right kidney pelvis, a partially filled kidney pelvis at level of fourth lumbar vertebra, inclined toward the right; no kidney shadow in its normal place on the left side. Catheterized specimens from right and left ureters showed total function of elimination maintained entirely by left kidney. Urine contained abundant red cells and pus cells: *Diagnosis.*—Right unilateral fused kidney; pyonephrosis and calculus of upper right kidney.

Operation.—September 21, 1931. Dr. B. A. Gingold, consultant. Kidney mass exposed by lumbar incision on right side; a mass the size of a football presented, consisting of the two kidneys fused (Fig. 1); upper kidney had a pelvic sac fifteen to eighteen centimetres in diameter attached to a kidney about 7.5 centimetres in diameter; the lower kidney was about two-thirds of the total kidney substance and had a normal pelvis. The sac was opened and removed with the intention of exposing the blood-vessels of the pedicle. This procedure was attended with such bleeding from the upper pedicle that after control had been established by ligation, it was thought best to postpone further surgery. Reaction was slow, with pulse of 168 and temperature of 105°. Catheterization was required every eight hours; patient became uncontrollable from bladder strangury which was relieved by cystostomy done on the fourth post-operative day. From that time his progress was uneventful. Urine continued to drain through the lumbar incision.

Two weeks later, the patient apparently restored to normal condition, a second operation was instituted. In the perirenal space, multiple pus pockets were opened into; line of demarcation between the upper and lower kidney was very clearly seen; the pedicle of the upper kidney was divided and the upper kidney sectioned from the lower kidney; hæmorrhage prevented by the placing of an intestinal clamp; hæmostasis imperfect; patient became pulseless, demanding cessation of the operation and active efforts to stimulation; the man slowly reacted and during the next twenty-four hours was transfused twice. Further stimulus supplied by proctoclysis, venoclysis and hypodermoclysis. Under this treatment he gradually recovered his strength. On October 18, two weeks after the second operation, while asleep, a secondary hæmorrhage started, requiring, after ineffectual primary effort at hæmostasis, re-opening of the wound and exposure of the kidney bed. Wound was packed with iodoform gauze with apparent stopping of hæmorrhage. Transfusion was again done. For some days his condition remained critical during which time repeated bleedings and transfusions characterized the case. He gradually succumbed and died October 25, 1931.

Fig. 1 represents the composite of the findings at operation and post-mortem. Microscopical examination of the kidney structure showed fibrosed glomeruli, numerous hyalinized tubules with some areas of lymphocitic infiltration.

Up to 1930, 111 of these anomalies have been reported in the literature, the majority drawn from autopsy material. Albarren, in 1909, was the first

to diagnose this anomally pre-operatively by introducing the then newly devised opaque catheters. Of these cases twenty-three have been operated upon. Four of them were done before the anomaly was recognized, with complete removal of the entire mass, resulting in death from anuria; thirteen were of

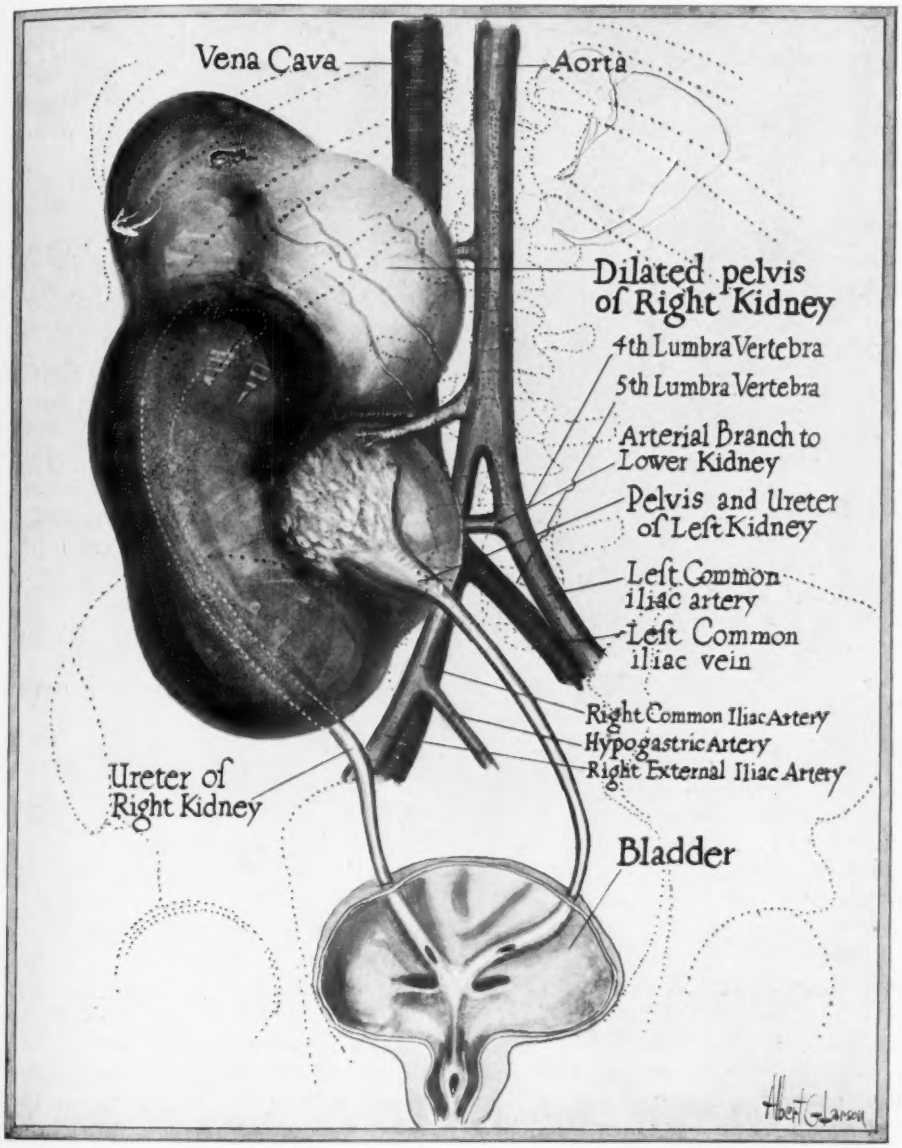

FIG. 1.

palliative nature for drainage, removal of a calculus, suspension of the kidney, or attempts at replacement; six have been associated with resection of one kidney, in two the upper, in four the lower half; all of them have dealt with the ectopic kidney as the diseased organ. This is the only case treated surgi-

cally in which the normally placed kidney has been the damaged portion. Also this is the only surgical death reported since 1909. Variations in this case from the normal were many anomalous vessels and nerves. The ureters were normally placed in the bladder, but the ureter of the upper kidney passed behind the mass, whereas it usually is placed in front. The lower ectopic kidney was rotated 45° to empty anteriorly, while the upper, as is customary, secreted toward the medial margin. The vessels entered the kidney substance posteriorly to the mass. The anomalous placement of the vena cava, also the difference of the aorta of the left renal artery, are well shown in the drawing.

This kidney anomaly is more common in men than in women, and usually causes trouble during the third decade of life. Young patients are more troubled with hydronephrosis, the older patients with pynonephrosis. In this case, the microscopical findings in the urine demonstrated that the infection had invaded the entire mass right from the start. Usually the transposed portion of the kidney is infected; in this case the normally placed organ was the one diseased.

The ideal treatment should be: First, ureteral drainage with later surgery. Failing in this: second, pyelostomy or nephrostomy with later surgery. This man should unquestionably have survived, had the infection been of milder nature, or his physical reserve less exhausted at the time of the onset of his illness. Both the post-operative hæmorrhages (delayed), and the terminal uræmia were results of the infection. A careful consideration of post-operative nephritis would be the only final resource.

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CONGENITAL ABSENCE OF VERMIFORM APPENDIX

THIS case is reported because of the rarity of this developmental anomaly and the misleading clinical picture presented by the patient. W. H., white, male, aged forty-one years, was admitted to hospital August 7, 1932, at 9:30 A.M. About 11 P.M. the day before admission he had been suddenly seized with generalized abdominal pains which became aggravated after a dose of castor oil. Nausea and vomiting ensued. The pain continued throughout the night.

On admission, ten and one-half hours after onset, he complained of abdominal pain, particularly in right lower quadrant, general malaise, marked anorexia, but no nausea or vomiting. The respiratory, genito-urinary, cardiovascular and nervous systems were negative. Abdomen showed marked tenderness in right lower quadrant with some spasm of the right rectus muscle. Temperature, 99.4°; pulse, 84; respirations, 22. White

blood-cells, 12,800, with 91 per cent. polymorphonuclears, 3 per cent. transitionals and 6 per cent. lymphocytes. Urine, negative.

Under a diagnosis of acute appendicitis, the abdomen was opened through a right rectus muscle-splitting incision. The serosa of the small intestine was reddened and an increased amount of peritoneal fluid was present. The cæcum was delivered and inspection of the entire region made but no appendix could be identified. The cæcum was then liberated by cutting the lateral peritoneal attachment to bring into view the retrocecal area without identifying the appendix. During this procedure three large blood-vessels were cut and ligated. At the time it was feared that the cecal blood supply was thereby impaired. A general exploration of the peritoneal cavity revealed no other pathology. The wound was closed without drainage.

After the operation the temperature rose to 102° F. and pulse to 115 during the first twenty-four hours. Subsequently the temperature varied between 100° and 103° F. and the pulse rate between 85 and 100 until the day of death. Abdominal distention developed early and persisted in spite of treatment (rectal tubes, gastric lavages and, later, various types of enemata and pituitrin). Dynamic ileus was diagnosed. From this time continued vomiting necessitated leaving a Levine tube continuously in place.

At 7 P.M., five days post-operative, he had sudden intense abdominal pain with a temperature drop, pulse rise, cold and moist skin, increased abdominal distention and generalized tenderness. Immediate laparotomy revealed a marked generalized peritonitis with fecal fluid free in the peritoneal cavity. An ileostomy was rapidly performed but the patient became progressively worse and died at 2:10 A.M. the next day—one week after onset of illness.

Surgical Comment.—Due to the fact that the appendix was not found intraperitoneal, we were too intent on trying to find a retroperitoneal appendix and by the intensive search damaged the blood supply to the ileocecal region with fatal results.

Autopsy demonstrated gangrene of the cæcum and ascending colon and in their walls three perforations, one to two centimetres in diameter. Within the corresponding mesentery there are several ligated blood-vessels. Thorough examination of the ileum, cæcum and ascending colon fails to reveal any evidence of the appendix. The terminal twelve inches of the ileum, the cæcum and the ascending colon with a large part of their mesenteries were removed in one piece and placed in fixing solution and later carefully studied in detail. The anterior tenia was followed to its termination, at which point the cæcum was smooth. The point of junction of the three teniæ was thoroughly examined. Not even a rudimentary projection to indicate the site of the appendix could be found. The serosal surface of the cæcum was everywhere smooth except for the site of the exudate and perforations. The mucosal surface was devoid of any dimpling which might suggest the orifice of the appendix. Numerous and practically serial sections were taken from the site of junction of the tenia and from immediately below the ileocecal valve. Histological examination has failed to reveal any tissue suggestive of appendix. Subsequently additional blocks of tissue were taken with the coöperation of the operating surgeon and they also proved negative for appendiceal tissue.

Comment.—The incidence of agenesis of the vermiform appendix, first recorded by Morgagni,[1] in 1719, has been thoroughly reviewed in the last two years by Bradley[2] and Spivak,[3] who added three cases to bring the total reported number to forty-six. Since the latter's article (submitted in December, 1930), no record of additional cases of this anomaly has been found. The same author mentions the fact that several of the cases reported are from unreliable sources; that some represent merely hypoplasia of the organ; and that the exact number of cases of true agenesis could be reduced

to about twenty-five. Bearing on the first fact, recently Dr. John F. Erdmann experienced difficulty in identifying the appendix and then remarked that he had never witnessed at the operating table an agenesis of the appendix and that he could readily understand the erroneous reporting of such ageneses by less experienced surgeons. In this connection we may mention a resected cæcum recently received in this laboratory with the clinical diagnosis of probable malignancy. In this case the pathologist identified the appendix only after prolonged and careful examination. We cite these instances to stress the point that a true agenesis is very difficult to establish with certainty at the operating table because sufficiently thorough examination of the cecal area is not practical—even if possible—at that time.

Critically considering such possibly incorrect reports, some of which will never be verified, and since the number of cases of each type will increase in proportion to the number of post-mortem examinations, it seems proper that a distinction be made between hypoplasia and congenital absence or agenesis of the appendix. In agreement with Spivak, we suggest that the number of reported cases of such agenesis be set arbitrarily at twenty-five, to which is added our case.

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DIVERTICULUM OF THE GALL-BLADDER

ANOMALIES of the gall-bladder are rare, and but very few references to such cases can be found in the literature. An anomalous gall-bladder of this type and complication has never been reported.

The reported cases are: Kremer,[1] Cholecystography in Diverticulum; Csillag,[2] Diverticulum of Gall-bladder; Barsony, T., and Friedrich,[3] Three Cases of Diverticulum of Gall-bladder; Sebening and Schondube,[4] Large Diverticulum of Gall-bladder, with Stenosis of Pylorus; Abbott,[5] Diverticulitis of Gall-bladder; in this case the diverticulum was near the fundus, no stones present nor was the gall-bladder highly pathological; Nadeau, O.,[6] Diverticulum of the Gall-bladder; this was undoubtedly a congenital anomaly, for there was no evidence of severe inflammation nor injury found in this region; Ross,[7] Pseudo-diverticulum of Gall-bladder; near the fundus a pouch was located which was examined microscopically and proved that only one side of the pouch thought to be that which corresponds with the interior of the gall-bladder proper. No such appearance was seen on the opposite side, so from these finds, as well as from the gross appearance, the pouch was not

congenital, but rather an acquired type; Michalski,[8] Diverticulum of the Gall-bladder; Kammerer,[9] Diverticulum of the Gall-bladder.

The case that I am about to report was not examined microscopically, so I cannot say definitely if it is or is not a congenital pouch. But at the time of operation the communication between the pouch and the gall-bladder proper was only one mm.

Case.—Mrs. R., a young married woman of twenty-seven years of age, had always been well before her marriage in 1927. Her weight at the time, 140 pounds, had gradually increased to 150 pounds during the three years following. In 1929, she noticed distress

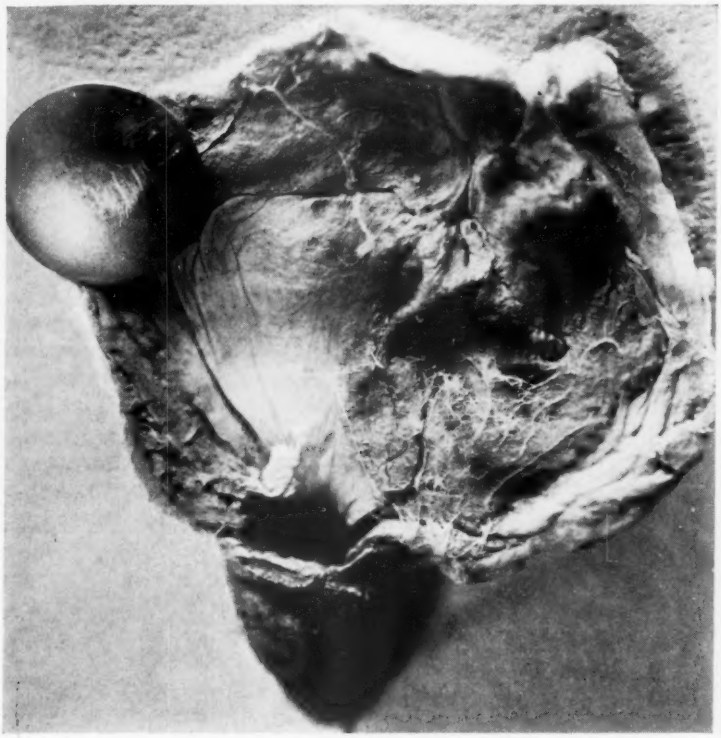

FIG. 1.—Diverticulum of gall-bladder.

after eating oranges but no other foods gave trouble. During her first pregnancy, in August, 1930, she suffered much from nausea, vomiting and belching during the entire period of gestation. Seven days after delivery, in June, 1931, she suffered a severe attack of belching, nausea and pain throughout the entire right abdomen and extending through to the right scapular region. Similar attacks of variable duration and severity recurred thereafter following extreme fatigue, or eating fatty foods, pastry or meats. In July, 1932, she complained of constipation. At this time she was slightly jaundiced. Late in October she had an attack of severe abdominal pain extending through to the back on the right with vomiting and nervousness. Temperature, pulse, and respirations were normal. After the pain had been present for a week and had been gradually getting worse she was taken to the hospital, where, under treatment, temporary relief was obtained. After two weeks the abdominal symptoms returned as before and operation was decided upon. An upper right-rectus incision was made. Upon opening the abdomen

a few adhesions in the region of the gall-bladder and liver were found; the tip of the gall-bladder was adherent to the jejunum; when freed, a diverticulum of the gall-bladder was found which had perforated the wall of the bowel (Fig. 1). The opening in the bowel was sutured. Upon further inspection the gall-bladder was found to be slightly thicker and more congested than normal. In the cystic duct was a stone three-quarters of an inch in diameter. This was milked back into the bladder before the duct was tied and the gall-bladder removed. The appendix appeared to be subacutely inflamed and was therefore removed. Drain was inserted lateral to the incision and wound closed in layers; recovery was uneventful.

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ADDENDA

July, 1933, issue

Page 1 last sentence to first paragraph should read "The surgery was performed chiefly by Dr. Harvey Righter and the author and their assistants."

Page 16, before Bibliography, paragraph to read: "I wish to thank Dr. Edward S. Dillon, Chief of the Metabolic Division at the Philadelphia General Hospital for his courtesy in allowing me to use the valuable records and material from his department as well as for his review of the manuscript. Thanks are also due his staff, especially Dr. Sidney Weinstein, for their assistance in rendering this data available."

June, 1933, issue

Page 949, on thirteenth line from bottom the name Bennett should read, Benedict (Edward B.).

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